POWER

Volume 48 New York, July 16, 1918 *Number* 3

YEARS ago John and George, classmates, graduated from college. As far as scholastic ability was concerned they were considered equals. John was inclined toward mathematics and theory, while George was more practical and more proficient in the shops and laboratories. Together they would probably have made a good team from the start. However, each went to his home town and was given, by his father, a start in life.

George decided that he wanted to begin as a fireman in an up-to-date power plant and learn all about power-plant operation from the bottom up, and had no difficulty in securing such work. His education helped him to perform his duties understandingly, and by the time he had finished his self-imposed course in power-plant engineering he could easily pass an engineer's license examination. He then sought out and found a town in which to build a power plant of his own, and under his supervision the building was speedily erected, the machinery installed, the tank built and the piping laid.

But John, the brilliant mathematician, when given an equal amount of money, started figuring. He figured that the power-plant field was promising, but that he would not build anything but the best. So he read books and magazines galore, traveled, hobnobbed with the leading power-plant designers, drew up tentative plans, then destroyed them because they were not perfect. Some new development looked better than his present plans, so he redesigned, but the years were slipping by. He heard from George about his plant and went out to inspect it, but criticized it most severely as being out of date, etc. And so it went year after year until John's allowance dwindled to nothing. His traveling, studying, planning and consulting had used it up.

Hearing that George now had a string of power plants, John applied for a "position." "All right," said George, "I can use a good up-to-date man like you. I am going to build a new plant, but it must be in full operation inside of 14 months and the ground hasn't been broken yet, and beginning now, you are in full charge."

This, at last, was John's chance to show what he could do, so he "dug in" and had a plant erected for George that was the pride of the decade, for his theory stood him in good stead. What he had needed all along was some of George's action, for theory alone won't do anything.

—*Contributed by S. F. Wilson.*

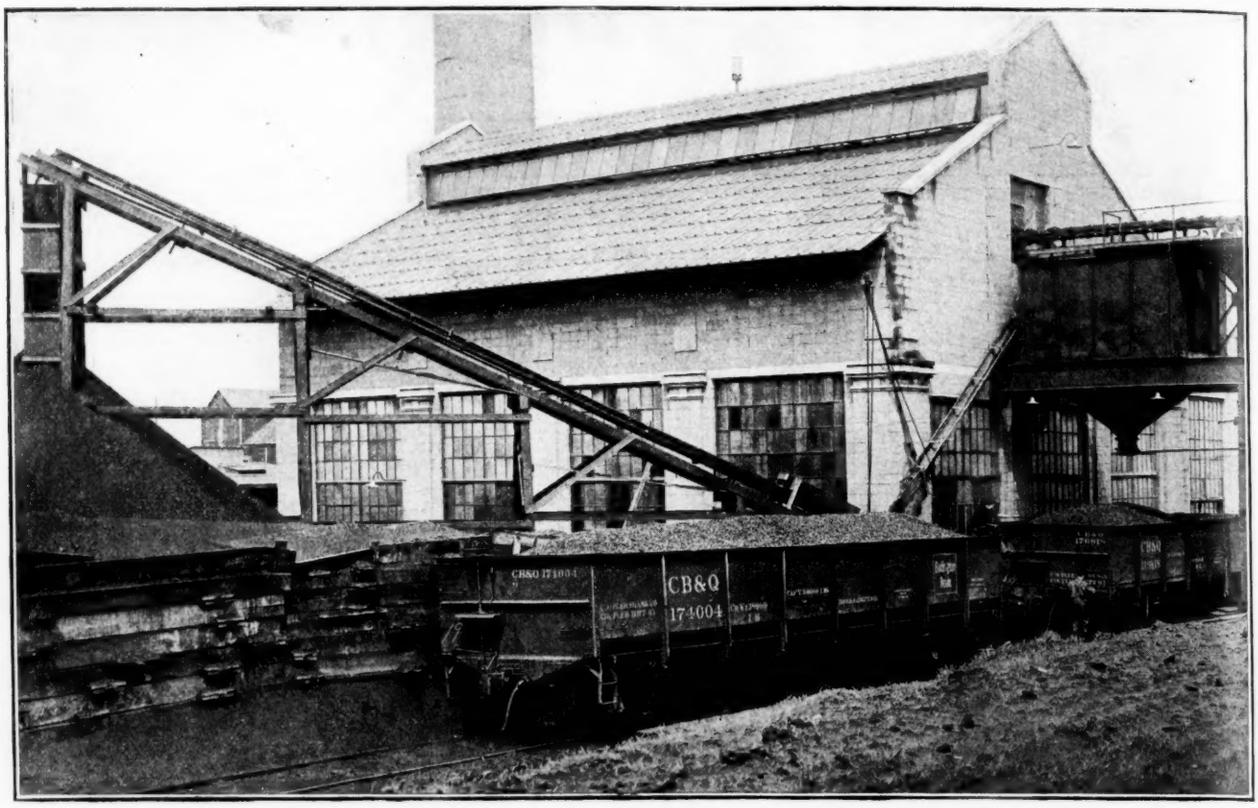


FIG. 1. SEMIPORTABLE CONVEYOR TIED UP TO POWER-PLANT SYSTEM

Storing Coal at Mooseheart, Illinois

A flexible system of portable conveyors tied in with the coal-handling equipment of the plant. Circular systems of piling adopted. Estimated cost of storing and reclaiming, 20c. per ton.

OWING to war conditions coal storage has become of unusual importance, and if instructions are followed more coal will be stored this summer than ever before in the history of the country. As a war expedient storage has become necessary and there are reasons why the present movement should continue in normal times. Equalization of the transportation problem—that is, moving as much of the coal as possible in the spring and summer instead of in the fall months, when the railway equipment is needed for handling crops, or in the winter, when the cost of operation is greatest—and the extension of the working mining period from two-thirds of, to a normal, business year—should result in a reduction in charges that would practically balance the cost of storage. These are possibilities of the future. To meet the present emergency, coal is being stored in numerous ways and by a wide variety of equipment. What has been done at the educational institution conducted by the Loyal Order of Moose, at Mooseheart, Ill., and the proposed extensions for this summer may be of interest.

As given in the description of the plant appearing in the Mar. 28, 1916, issue of *Power*, the boiler-room equipment consisted of two 372-hp. water-tube boilers and a 200-kv.-a. generating set. Owing to completion of new buildings and increasing demand for steam, a 150-hp. return-tubular boiler, a temporary unit, was added to the equipment, and this summer will see the installation of a 450-hp. water-tube boiler to help out on next winter's heating. There will be 120,000 sq.ft. of direct radiation to supply with steam, as compared to 75,000 sq.ft. in 37 buildings last winter.

In the plant coal is elevated to 40-ton overhead bunkers by a continuous bucket conveyor having a maximum capacity of 30 tons per hour. Coal is received through a railway track hopper at the side of the building. About 8500 tons of 1¼-in. Franklin County nut and ¾-in. screenings was burned last year, and with the increasing demands on the plant it is expected that the consumption for the coming year will approximate 11,000 tons.

Anticipating some of the difficulties that were experienced later on in obtaining an adequate supply of fuel, storage was begun in the summer of 1917. A sectional semiportable Barber-Greene conveyor was tied up with the coal-handling system in the plant, and 3000 tons of mixed nut and screenings were stored in one pile adjacent to the boiler room. This conveyor is 60 ft. long and is equipped with an 18-in. endless four-ply canvas belt driven by a 5-hp. motor mounted at one end of the frame. When uniformly loaded, the conveyor has a capacity of 40 tons per hour and operates at an angle of 25 deg. to the horizontal. It is made up in 12-ft. lengths so that it can be erected readily or dismantled. It rests on a permanent timber structure.

Coal for storage was received as usual through the track hopper, as shown in Fig. 1; it was elevated to the top run of the continuous conveyor in the plant and discharged through a chute to the base of the semiportable conveyor, the latter discharging the coal onto the storage pile. In order to get the 3000 tons in one pile the coal was pulled back from the conveyor by an improvised scraper. A 7½-hp. gasoline engine with a drum provided with 200 ft. of ⅝-in. cable pulled the scraper. A rope attached to the back of the scraper and passing around a pulley on the opposite side of the pile was used to pull the scraper back to the starting position. The loose end of the rope was brought back to the engine and, with the drum thrown out of gear, was given a half-inch around the capstan, so that the engine did the work. To perform this operation three men were required—one to handle the scraper, one to operate the engine and the third to place the rope on the capstan. During the coming season reclaiming will be effected by laying the semiportable conveyor flat on the ground, turning it end for end and directing it to discharge the coal shoveled onto it from the pile, into the railway-track hopper, the plant conveyor then handling the fuel as usual. With so much rehandling, storage last summer proved rather expensive, the labor cost for storing and reclaiming exceeding 40c. per ton. In addition fires developed and a great deal of shifting with the scraper had to be done before they were under control.

The first summer of storage was profitable in that several things to be avoided were learned by experience. By the use of the scraper water pockets were left in the pile, helping to disintegrate the coal, and the screenings were stored with the nut coal, an ideal condition for spontaneous combustion. The fine coal fills in the interstices between the lumps, shutting off the circulation of air, and when piled in alternate layers as it would be in this case, conditions are more unfavorable, as the coarse coal will allow sufficient air to get through to feed a fire in the fine coal, but not enough to keep down the temperature.

A retaining wall of planks had been built up around the pile of coal. Flat boards, 1 x 6 in., were stuck into the coal horizontally to support the planks, and cleats nailed across the ends held them in place. Fires started in several places around the outside and near the bottom of the pile. The heating was first observed around the boards supporting the retaining wall. Eventually, they caught fire and had to be removed. The scraper was used to work over the pile in an effort to remove the burning coal, and it had to be retained in service nearly all summer. Perforated iron pipes were driven down into the pile with the intent to ventilate and cool the coal, but the only effect they seemed to have was to furnish enough air to burn the coal immediately surrounding the pipes.

This year the storage piles will be smaller and arranged so that burning coal may be readily removed; there will be no extraneous matter in the coal such as wood or oily waste to precipitate a fire, and an effort will be made to pile separately the screenings and the lump or nut coal. The proposed layout is shown in Fig. 2. It will be noticed that a portable conveyor mounted on an adjustable two-wheeled truck and a pivoted chute connecting it with the semiportable conveyor installed in 1917 has been added to the equipment. The portable conveyor has a four-ply endless 18-in. rubber belt, 51 ft. long between pulley centers. The capacity is the same as that of the other conveyor, and the driving force is supplied by a 5-hp. motor mounted in the frame.

In storing the coal this summer, the central pile fed by the semiportable conveyor will be allowed to assume its natural angle of repose, about 40 deg. There will be no scraping back from the conveyor. With the apex 30 ft. above the base, the pile will contain approximately 960 tons of coal. With the end of the semiportable conveyor as a center the coal will then be stored in a circular pile or, rather, series of piles around the central storage by means of the connecting chute and the portable conveyor shown. The limitations of the property allow an arc of 180 deg. for the outside pile. Its dimensions will be about 46 ft. wide and 19 ft. high to the apex, and the storage about 3000 tons. With the layout previously described, heating of the coal will present no serious difficulty. Burning coal at any point can be removed with facility.

As it is the intention to store as much of the coal consumed annually as it is possible to obtain, a similar system will be started on the opposite side of the coal spur, where there is room for a complete outside circular pile, giving an additional storage of 6000 tons. In this event it will be necessary to lengthen the semiportable conveyor from 60 to 132 ft. and use a 7½-hp. motor to drive it. The belt is spliced with alligator lacing, so that the additional length can be inserted and the required number of sections can be added easily to the frame.

Reclaiming from the central piles will be effected by flattening out the semiportable conveyor, turning it

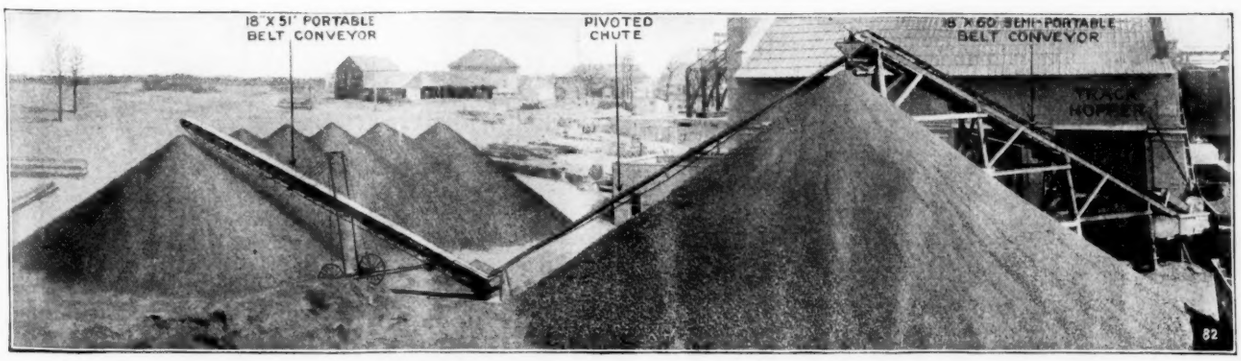


FIG. 2. CIRCULAR METHOD OF PILING USING BOTH PORTABLE AND SEMIPORTABLE CONVEYORS

end for end and shoveling onto it from the pile. From the circular pile the coal will be shoveled to the portable conveyor, discharged on the semiportable outfit and delivered into the track hopper, from which the power-plant equipment will elevate it to the overhead bunkers. A self-loader, in reducing the labor requirements, would lessen the cost of reclaiming the coal, and it is possible that such an apparatus may be used.

Flexibility and comparative cheapness are the outstanding features of the equipment under discussion. The initial cost was close to $2000. With the equipment out in the open an allowance for depreciation and upkeep of 15 to 20 per cent. for the frame should be conservative. A commonly accepted figure chargeable to belt wear is ½ to 1c. per ton of coal handled. Interest on the investment may be placed at 6 per cent. With these figures the fixed cost per year will depend on the amount of coal stored. Although with the present layout and equipment there is room for 10,000 tons, the estimate will be made on 6000 tons. Depreciation and upkeep of 20 per cent. on the frames of the conveyors will amount to $200 (the belts forming about one-half of the investment) or 3⅓c. per ton. Belt wear at 1c. per ton will total $60, and interest at 6 per cent. on $2000 will amount to $120. The total fixed charges per year will then be $380, reducing, on the basis of 6000 tons, to 6⅓c. per ton.

The operating charges depend on the power-plant facilities for receiving coal, which are limited to three cars (120 tons) per day of eight hours. In storing coal two men at $3.50 per day will be required. The labor charge reduces to 6c. per ton. In reclaiming, three men at $3.50 per day will be used, and each can readily shovel 5 tons per day, so that the cost is 7c. per ton. A self loader having a capacity of 25 tons per hour and costing about $1000 would reduce this figure. The cost of power, grease, etc., will be slight, so that storing and reclaiming the coal should cost close to 20c. per ton. This figure does not include the cost of running the power-plant conveyor when storing the coal, so that the total cost will be slightly in excess of the amount given. Even then the cost is low considering the tonnage. It is a good indication of what may be done in a small plant.

Gasoline and Its Dangers

By Augustus H. Gill

THE term gasoline was formerly applied to the higher portion obtained by distilling crude petroleum, more particularly that above 80 deg. Baumé (pronounced bomay). The name means "like gas" and is derived similarly to "butterine" and other words of like ending.

Owing to the present great demand for gasoline, anything lighter than kerosene (45 deg. Baumé), and even some of that, finds its way into the commercial article, which then becomes really naphtha, an intermediate product. This designation "deg. Baumé" refers to degrees on the hydrometer devised by Baumé for measuring the densities of liquids lighter than water. It is a weighted glass spindle which sinks to a greater or less depth in a liquid, according as it is light or heavy. Thus in water it sinks but 10 deg., in engine oil to 25 deg., in kerosene to 45 deg., in motor gasoline to 60 deg. and in illuminating gasoline to 86 deg. These are spoken of as "86-deg. gasoline," etc. But this designation refers simply to the weight of the liquid, or "gravity" as the oil man says, and it has nothing to do with boiling point, freezing point or percentage composition; it is simply a commercial way of naming the different grades. To a certain extent, however, it is a measure of the volatility, or ease with which it is converted into vapor, for the higher the number or "test" the more readily is the gasoline changed into vapor. While this "gravity" or hydrometer test is the one commonly employed, it is a very unsatisfactory and unreliable test, as mixtures can be made which will have the same gravity and yet one will be very unsatisfactory; for example, a mixture of equal parts of 56 and 86 deg. and one of 25 per cent. each of 56, 66, 76 and 86 deg. will have the same gravity (71 deg.), and yet the latter will work much better than the former, which will vaporize irregularly and tend to make an engine run unevenly. This extremity of mixture would be revealed in a distillation test that consists in boiling the gasoline, condensing the vapor to a liquid and noting the quantities that come over at the different boiling temperatures. In the gasoline made up equally of an 86- and 56-deg. mixture the quantity of low-boiling and of high-boiling distillate would run nearly even in volume.

Gasoline is made in three different ways: First, by distilling crude petroleum on a large scale, as is done on a small scale in the distillation test just described; second, by "cracking" the heavy oils, engine oils, etc., by great heat and pressure (Rittman and other processes); third, by causing natural gas under pressure to pass through cooled tubes when the gasoline vapors it contains are chilled out of it (this is called "casing-head" gasoline).

While gasoline ignites at 1400 deg. F., a dull-red heat, it cannot be ignited by a soldering copper, a cigar or cigarette, but woe to the man who uses a blowtorch or lights a match in the proximity of gasoline vapor. The temperature of these flames is about 2100 deg. F., therefore much above the ignition point of gasoline. In use it is ignited by a voltaic or dynamic spark, but the fact must not be overlooked that it can also be fired by frictional electricity. One of the earliest accidents of record caused by frictional electricity was the "hair-dresser's accident" in 1897. A woman was being shampooed with a wash containing gasoline when sufficient frictional electricity was generated to produce a spark which ignited the vapor, burning her so severely that she died. A naval surgeon wearing a fur coat and rubber boots (which insulated him from the ground) made a spark, presumably by friction on the fur, sufficient to ignite the gasoline in the tank of an automobile. Sparks of considerable intensity are not infrequently generated from furs. Gasoline is electrified by passing through chamois skin or a rubber hose. Automobiles have been set on fire by a spark from a chamois-lined funnel used in filling the tank, and perhaps insulated from it by a wooden block or from a hose through which gasoline is pumped when the cock on the end did not touch the tank. The chamois should be replaced by 80- to 100-mesh brass gauze, and the hose and cock should be grounded by a chain connecting

them with the metal storage tank. In filling cans, for example, they should be connected with the gasoline pump by a chain or wire because sometimes the friction of the gasoline in the pipes makes electricity enough to cause a spark to jump from the pump to the can, firing the gasoline.

In handling gasoline it should be remembered that the vapor is heavier than air (3.5 times) and settles. It flows like a stream and has been known to run in a stratum and become ignited from a boiler fire 60 ft. away. Gasoline does not explode except in a confined space; the explosive range, that is, the percentage necessary to make air explosive, is between 1.5 and 6. In other words, an air mixture containing one and one-half to six volumes of the vapor in one hundred is explosive. Putting it another way, two quarts of gasoline, if diffused through a room 10 x 10 x 10 ft., would make a first-rate explosion. This is equal to about 5 tablespoonfuls in a 5-gal. can. The following table shows the number of cubic feet of vapor produced by different quantities of gasoline:

Liquid Gasoline	Gasoline Vapor, Cu.Ft.
128 liquid oz. (1 gal.)	32
64 liquid oz. (2 qt.)	16
32 liquid oz. (1 qt.)	8
8 liquid oz. (½ pt.)	2
4 liquid oz. (1 gill)	1
½ liquid oz.	¼ (App. 1 gal.)

One volume of the liquid becomes 240 volumes in the vaporous condition.

The heating value of gasoline varies from about 17,860 B.t.u. (for 62 deg. Baumé) to about 18,080 B.t.u. (for 76 deg. Baumé) per pound, or 109,024 and 102,152 B.t.u. per gallon respectively; that is, the heavier gasoline has the greater heating value per gallon and less per pound.

Using Hogged Mill Refuse as Fuel

The Portland Railway, Light and Power Company is storing a pile of hogged fuel which will contain about 12,000 units of 200 cu.ft. each, or the equivalent of 26,400 bbl. of oil. This is to be used during the low-water season this year at Station L, the steam generating plant on the Willamette River in the City of Portland. This plant is adjacent to a sawmill where the fuel, which is too bulky for long haul, can be delivered by conveyor.

This fuel consists of sawmill refuse that has usually been wasted heretofore or, where the sawmills are within the city limits, had to be burned at some expense to the company. The waste material is now put through a grinder and mixed with sawdust, shavings and chips from the mill machines. The amount of hogged fuel equivalent to a gallon of oil varies with the relative quantity of shavings and finer dust, but usually ranges from 1.7 to 2.3 cu.ft.

The conveyor on which the hogged fuel is brought to the storage pile at the Portland plant is carried on 45-ft. poles and is constructed so that the material drops through traps at the desired points. To prevent the material from piling up directly under the conveyor, it is raked away as it accumulates by two large forks built especially for the purpose. These are operated by a motor-driven hoist and a donkey-engine hoist, each fork being handled by ¾-in. plow-steel cable with a ⅝-in. return line. With this arrangement the material can be piled 50 ft. high and can be taken about 250 ft. from the center of the pile.

Conveyors are to be built later to take fuel from the farthest end of the pile to a point just outside the stockhouse, where an incline conveyor will take it up into the bunkers. From the stockhouse to the boilers an additional 160 ft. is spanned by still another conveyor.

Acceptance of Equipment

A city having bought soot blowers for use in a power plant, under an agreement giving the city sixty days in which to try the blowers out and providing for their return within fifteen days after expiration of the trial period, retention of the equipment for four months precluded the city from demanding rescission of the purchase on the ground that it was induced through misrepresentations on the seller's part. And if the blowers were never subjected to trial, the city was not entitled to defeat recovery of the price on the mere opinion of its engineer that use of the blowers would prove to be injurious to the boilers. (Kansas City Court of Appeals, Bayer Steam Soot Blower Co. vs. City of Milan, 199 Southwestern Reporter, 712.)

POWER-OPERATED FORKS ARE USED TO SPREAD THE PILES OF HOGGED FUEL

Underground Pipe Mains—Material, Depreciation, Sizes for Steam and Water

By CHARLES L. HUBBARD

While many of the data contained in the following article will apply to distributing mains wherever located, special consideration has been given to underground piping and such as occurs in central heating and the distribution of steam and water for various industrial purposes.

THE choice of material for underground piping evidently lies between steel and wrought iron, whether for steam or water. Much has been written upon the advantages and disadvantages of these two materials, and although apparently based upon equally good authority, much contradictory matter is found in making a study of the subject. After a careful review of numerous papers, it would seem that more depends upon local conditions than upon the material itself. Various cases are reported where steel and iron pipes have been used for the same purpose in the same locality and after years of service very little difference has been noticeable in the physical condition of the two metals. In some cases one would appear to have the advantage, while in others the condition would be reversed.

Difference Between Wrought Iron and Mild Steel

While the chemical composition of wrought iron and mild steel is very nearly the same, the difference consisting in the impurities and variations in structure causes them to act somewhat differently under similar conditions. For example, steel is refined in molten form and cast into ingots, thus having a homogeneous structure, and any impurities it may contain flock together in irregularly distributed groups and produce the variation of quality often found in a single piece of steel.

Wrought iron is refined at a lower temperature than steel and is removed from the furnace in the form of a porous mass, the cavities of which contain more or less fluid cinder. These "balls," dripping with cinder, are first forged or squeezed, then rolled into bars. This manipulation forces out part of the cinder, but sufficient remains in the form of thin films to give the iron a fibrous structure. These films, consisting of silicate of iron, similar to the outer skin of cast iron, resist corrosion much better than pure iron or steel, which is without this protection. On the other hand, strong acid solutions will readily dissolve the cinder films, slightly honeycombing the iron and making it corrode easily. Corrosion in the case of pipes may take place upon either or both the exterior and interior surfaces, and is caused by oxidation, a process requiring the presence of both moisture and air. This is guarded against by keeping moisture from the outside of the pipe and air from the inside so far as possible. Internal corrosion is due to the presence of oxygen in the water, which is given off when heated.

Experiments show that water and air are most actively corrosive between 140 and 180 deg. F. and that oxygen is practically all separated from the water at 210 deg. F., provided it can escape to the atmosphere. However, in the transmission of steam or hot water under pressure, the gases are forced to remain in solution unless special means are provided for their removal, and under these conditions are most active. It is frequently noticed in old hot-water mains that the upper part of the pipe is appreciably thinner than the lower, due to the oxidizing effect of the air, which tends to rise to the upper part of the pipe when the velocity of the water is comparatively low. In the case of hot-water heating systems, where the same water is circulated continuously, means are sometimes provided for removing the air before it is put into circulation. If an open system is employed, a vent pipe carried from the top of the flow main, where it leaves the heater, to the expansion tank will gradually remove the air and other gases, which are lighter than water and naturally rise to the highest point. As these gases are driven off by heating, most of them may be taken off by arranging the piping in this manner. In the case of a closed system a vent pipe carried to an air trap located at an elevation above the highest radiator will answer much the same purpose, although the higher pressure tends to keep the air in solution. Where the water is to be used at a temperature lower than that necessary to drive off the dissolved gases, it may be first heated under atmospheric pressure, with a free vent, and then passed through a cooler similar to a closed feed-water heater, in which a portion of its heat may be given up on its way to the heater.

Material for piping which is to convey superheated steam may be the same as for saturated steam so far as the pipe itself is concerned, the necessary difference in line construction being in connection with the joints. Full-weight pipe seems to be suitable for the temperature and working pressures up to 225 or 250 lb. if it is not thinned at any point by cutting and threading. As modern methods of joint construction for superheated steam do away with threading, this weight of pipe seems to meet all ordinary requirements as to strength. In regard to pipe connections, either the welded or van stone joint is usually made use of. Both of these, however, require special qualities found to the highest degree in openhearth steel.

Depreciation Depends on Local Conditions

The depreciation of underground pipes is so influenced by various local conditions that it is impossible to give any definite figures for general use. The life of the piping will depend largely upon the amount of moisture that reaches the outside surface, although a certain amount of corrosion takes place inside, as already noted. The following figures, published some time ago, are based on a careful inspection of a system of hot-water heating when the mains were packed in oiled shavings and inclosed in a wooden conduit. The life of the pipe for different sizes is estimated as follows: 2-in., 22

years; 3-in., 32 years; 4-in., 35 years; 5-in., 38 years; 6-in., 41 years; 8-in., 47 years; 10-in., 53 years; 12-in., 55 years.

The longer life given to the larger sizes is due to the greater thickness of stock and not to the diameter of pipe.

Pipe Sizes for Steam

There are various methods of computing the sizes of steam mains, depending on the degree of accuracy required. In the average case extreme refinements in the assumed conditions are not necessary because there are so many factors affecting the flow of steam or water in a system of piping which cannot be accurately determined beforehand. For those who wish to make exact computations for special conditions, it may be well to include the well-known D'Arcy formula in its different forms for the flow of steam, after which will be given tables of computed results for the more common conditions met with in practice.

(1) $Q = c\sqrt{\dfrac{(p - p_1)d^5}{wl}}$ (2) $W = c\sqrt{\dfrac{w(p - p_1)d^5}{l}}$

(3) $d = \sqrt[5]{\dfrac{W^2 l}{c^2 w(p - p_1)}}$ (4) $p - p_1 = \dfrac{Q^2 wl}{c^2 d^5}$

in which

Q = Cubic feet of steam per minute;
W = Weight of steam per minute in pounds;
w = Weight of a cubic foot of steam at pressure p;
p = Initial pressure, in pounds per square inch;
p_1 = Final pressure, in pounds per square inch;
d = Diameter of pipe, in inches;
l = Length of pipe, in feet;
c = A constant, depending upon diameter of pipe.

These values are given in the table following:

TABLE I

Diameter of Pipe	Value of c	Diameter of Pipe	Value of c
3	56.1	8	60.7
4	57.8	9	61.2
5	58.4	10	61.8
6	59.5	12	62.1
7	60.1	15	62.6

Table II has been computed from the foregoing formulas and covers most conditions found in low-pressure heating. The results are very nearly correct for pressures up to 5 lb. gage, and cover drops in pressure ranging from $\frac{1}{16}$ lb. to 1 lb. per 100-ft. length of straight pipe.

TABLE II. (LOW-PRESSURE STEAM). FLOW OF STEAM, IN POUNDS PER MINUTE, THROUGH DIFFERENT DIAMETERS OF PIPE, WITH DIFFERENT DROPS IN PRESSURE PER 100 FT. LENGTH OF RUN

Drop in Pressure, Lb.	Diameter of Pipe, in Inches									
	3	4	5	6	7	8	9	10	12	15
$\frac{1}{16}$	4.3	9.1	16.1	40.8	38.5	54.0	73	96	152	267
$\frac{1}{8}$	6.1	12.7	22.5	36.2	53.9	75.6	104	134	213	374
$\frac{1}{4}$	8.6	18.1	32.2	51.7	77	108	147	192	305	535
$\frac{1}{2}$	12.3	25.7	45.7	73.3	109	154	209	273	434	761
$\frac{3}{4}$	15.2	31.8	56.6	90.9	135	190	258	339	537	942
1	17.6	36.9	65.7	106.0	157	222	299	393	623	1090

Example: It is desired to transmit 150 lb. of low-pressure steam per minute a distance of 1600 ft. with a total drop in pressure not exceeding 1 lb. What diameter of pipe will be required?

A total drop of 1 lb. pressure in 1600 ft. means a drop of $\frac{1}{16}$ lb. per 100 ft. Following along the line opposite $\frac{1}{16}$-lb. drop in pressure in Table II, we find a 12-in. pipe will discharge 152 lb. of steam per minute and is the size required. If a 2-lb. drop were allowable, the drop per 100 ft. would be $\frac{1}{8}$ lb., in which case a 10-in. pipe discharging 134 lb. might be made to serve the purpose by increasing the drop slightly over two pounds.

The best combination of pressure drop and pipe size will depend on circumstances. In some cases it may be possible to vary the pressure and so reduce the size of pipe, thus saving in first cost; while in others this might raise the back pressure on the engine and so increase the operating cost above that which would be saved by using a smaller pipe. Operating cost and the first investment must, therefore, always be considered together when laying out work of this kind.

Table II applies to any condition where steam is required, regardless of its use. When applied to direct heating, it is customary to allow a radiator efficiency of about 250 B.t.u. per sq.ft. of surface per hour, which for steam at 2 lb. pressure calls for 250 ÷ 970.4 = 0.26 lb. of steam per sq.ft. of surface per hour. Increasing this for radiation losses from piping, etc., brings the amount up to about 0.3 lb. for average conditions. When hot-blast heaters are used, either alone or in connection with direct radiation, count each square foot of such surface as six of direct surface when determining the size of pipe main for supplying a building or plant.

Table III has been made up from curves published by Byron T. Gifford some years ago in the *Metal Worker* and is interesting for purposes of comparison with results obtained from Table II. In connection with the curves referred to and their uses, Mr. Gifford says: "There are, of course, other ways of designing central-station pipe lines somewhat more elaborate and a great deal more lengthy, but the method outlined is accurate for any central-station layout and has the advantage of being rapid as well as reliable." As previously stated, the figures in Table III were read from a curve and are therefore subject to a certain amount of inaccuracy due to the smallness of the scale.

TABLE III. SQUARE FEET OF DIRECT STEAM RADIATION WHICH MAY BE SUPPLIED BY MAINS OF DIFFERENT SIZES, WITH VARYING DROPS IN PRESSURE IN 100 FEET

Drop in Pressure, Lb.	Diameter of Pipe, in Inches									
	4	5	6	7	8	9	10	12	14	16
$\frac{1}{4}$	5,600	7,500	12,000	17,000	23,000	33,000	45,000	70,000	100,000	150,000
$\frac{1}{2}$	6,200	10,000	17,000	25,000	33,000	45,000	64,000	98,000	143,000	205,000
$\frac{3}{4}$	7,600	13,000	20,000	30,000	40,000	56,000	77,000	120,000	175,000	255,000
1	8,600	15,000	23,000	35,000	46,000	67,000	88,000	138,000	205,000	340,000

From Table III we find an 8-in. pipe with $\frac{1}{2}$-lb. drop in pressure will supply 33,000 sq. ft. of radiation. From Table II we find an 8-in. pipe with $\frac{1}{2}$-lb. drop in pressure will discharge 154 lb. of steam per minute, or 154 × 60 = 9240 lb. per hour. Allowing 0.3 lb. per square foot of radiation, including piping, this will supply 9240 ÷ 0.3 = 30,800 sq.ft., which corresponds closely with Table III.

Table IV has been prepared for average conditions of high-pressure work, assuming an intial pressure of 100 lb. gage and pressure drops ranging from $\frac{1}{2}$ lb. to 5 lb. per 100 ft. of pipe.

TABLE IV. (HIGH-PRESSURE STEAM). FLOW OF STEAM, IN POUNDS PER MINUTE, THROUGH DIFFERENT DIAMETERS OF PIPE, WITH DIFFERENT DROPS IN PRESSURE PER 100 FT. LENGTH OF RUN

Drop in Pressure Lb.	Diameter of Pipe, in Inches									
	2	3	4	5	6	7	8	9	10	12
$\frac{1}{4}$	10.7	31.7	66.3	117.9	189	281	397	539	704	1119
$\frac{1}{2}$	15.5	45.4	95.2	169.5	273	405	573	774	1014	1607
2	22.3	65.5	137.5	244.3	392	583	825	1114	1467	2322
3	28.1	82.5	173.3	309.6	495	735	1037	1406	1844	2915
4	33.5	98.2	206.4	366.3	588	877	1233	1677	2198	3583
5	38.4	112.7	237.3	420.5	676	1006	1419	1922	2520	4000

The allowable drop in pressure for high-pressure work will depend somewhat upon actual conditions, but

in general should be checked for velocity. This for straight runs of pipe, with saturated steam, may be taken as about 5000 ft. per min. for 4-in. pipe, up to 10,000 ft. for 12-in. pipe, but under some conditions higher velocities, 6000 to 12,000 ft., may be allowed for straight runs of pipe. If the mains have a number of bends, valves, etc., it is well to reduce these velocities about 20 per cent. Velocity of flow is easily computed by the following formula, together with Tables V and VI:

$$V = \frac{144 \times W \times S}{A}$$

in which

V = Velocity, in feet per minute;
W = Pounds of steam flowing through pipe per minute;
S = Volume of 1 lb. of steam, in cubic feet at given pressure and temperature;
A = Area of pipe.

TABLE V. INTERNAL AREA OF WROUGHT-IRON PIPE, IN SQUARE INCHES

Diameter of Pipe In.	Internal Area Sq.In.	Diameter of Pipe In.	Internal Area, Sq.In.
2	3.35	7	38.7
3	7.38	8	50.0
4	12.73	9	63.6
5	19.99	10	78.8
6	28.89	12	113.1

TABLE VI. VOLUME OF 1 POUND OF STEAM AT DIFFERENT PRESSURES.

Gage Pressure Lb. per Sq. In.	Volume of 1 Lb. in Cu. Ft. Saturated Steam	Superheated 150 Deg.
80	4.6	5.7
100	3.8	4.7
120	3.3	4.1
140	2.9	3.6
160	2.6	3.2
180	2.3	2.9
200	2.1	2.6

Example: From Table IV we find that an 8-in. pipe will discharge 825 lb. of steam per minute with a drop in pressure of 2 lb. per 100 ft. of length. What will be the approximate velocity of flow for saturated steam at 140 lb. pressure?

Here we have $W = 825$; $S = 2.9$ (from Table VI), and $A = 50$ (from Table V). Substituting in the formula gives $V = \frac{144 \times 825 \times 2.9}{50} = 6890$ ft. per min., which should be safely within the limits for a pipe of this size.

Pipe Size for Hot-Water Heating

The following refers especially to the mains for hot-water heating under forced circulation and is based on the friction head and velocity of flow. Tables or curves are often prepared for determining the size of main for the radiation to be supplied under given conditions. The volume of water to be circulated in any given case depends on the heat units to be given off by the radiation and the allowable drop in temperature of the water in making the circuit. While the initial temperature of the water and the drop are variables within certain limits, we may assume for average conditions an initial temperature of 190 deg. and a drop of 20 deg., giving an average temperature of 180 deg. to the water in the radiators. Under these conditions we may assume that each square foot of direct radiating surface will give off 200 to 300 B.t.u. per hour, or from 2 to 3 B.t.u. per sq.ft. of radiating surface per degree difference between the heating medium and the surrounding air. This is slightly more for cast-iron sectional radiation and slightly less for pipe coils, but is a good figure to use when the exact conditions are not known and is sufficiently accurate for all ordinary work. Knowing the square feet of radiation to be supplied, we may determine the gallons of water to be circulated per minute by multiplying the square feet of radiation by 200 (and increase 20 per cent. for loss from piping). This will give the B.t.u. to be supplied per hour, and this in turn divided by 60 will give the heat loss per minute. One gallon of water weighs 8.3 lb., and in cooling 20 deg. will give off $8.3 \times 20 = 166$ B.t.u. Hence, the total heat given off by the radiating system per minute divided by 166 will give the gallons of water to be circulated in the same length of time. This written as a formula becomes

$$G = \frac{R \times (200 \times 1.2)}{60 \times 8.3 \times 20} = R \times 0.024$$

in which G = gallons of water to be circulated per minute, and R = square feet of direct radiation to be supplied. Some prefer to use the figure 0.03, which gives a slightly larger factor of safety.

The allowable velocity depends somewhat on the size of pipe, commonly ranging from 3 or 4 ft. per sec. in mains of small size up to 10 ft. in larger ones. Smaller mains are less expensive to install, but increase the friction head and cost of pumpage; hence, a compromise must be made to secure the most economical results. Allowing a velocity of 1 ft. per sec. for each inch in diameter of the pipe is a good general rule to follow for mains ranging from 3 to 12 in. in diameter. The friction head is commonly limited to 30 or 40 ft., although considerably higher pressures are sometimes allowed by using circulating pumps especially designed for these conditions. Table VII gives the volume of water, friction heads and velocity of flow for different sizes of pipe within the range commonly made use of in hot-water heating.

TABLE VII. FRICTION HEADS AND VELOCITY OF FLOW IN HOT-WATER HEATING MAINS. LENGTH OF PIPE 100 FEET

Diam. of Pipe	2½ In.		3 In.		4 In.		5 In.		6 In.		8 In.		10 In.	
Gal. Discharged per Min.	Friction Head in Feet	Velocity in Ft. per Sec.	Friction Head in Feet	Velocity in Ft. per Sec.	Friction Head in Feet	Velocity in Ft. per Sec.	Friction Head in Feet	Velocity in Ft. per Sec.	Friction Head in Feet	Velocity in Ft. per Sec.	Friction Head in Feet	Velocity in Ft. per Sec.	Friction Head in Feet	Velocity in Ft. per Sec.
50	2.1	3.3												
60	2.9	3.9												
70	3.9	4.6												
80			2.3	3.6										
90			2.8	4.1										
100			3.4	4.5										
150					1.8	3.8								
200					3.1	5.1								
250					4.6	6.4								
300							2.1	4.9						
350							2.9	5.7						
400							3.9	6.6						
500									2.3	5.7				
600									3.2	6.8				
700									4.2	7.9	1.1	4.5		
1000											2.2	6.4		
1250											3.4	8.0		
1500											4.8	9.6	1.6	6.1
2000													2.8	8.1
2500													4.4	10.2
3000													6.3	12.2

When there are a number of turns in the pipe, they will add materially to the friction head and should be taken into account by allowing an extra length of pipe for each fitting. Generally, 10 and 20 ft. should be allowed for short-turn ells and tees and one-half this amount for fittings of the long-turn pattern.

Example: The total length of a hot-water main is

2000 ft. and 10,000 sq. ft. of radiation is to be supplied. What should be the diameter of the pipe for average conditions? Gallons of water to be circulated per minute = 10,000 × 0.024 = 240.

Looking in Table VII we find for 250 gal. (the nearest amount) a 4-in. main will require a friction head of 4.6 × 15 = 69 ft., which is too high. Taking the next size, we find a 5-in. pipe will discharge 300 gal. per min., with a friction head of 2.1 × 15 = 31.5 ft. at a velocity of 4.9 ft. per sec., well on the side of safety.

Table VIII corresponds to Table III excepting that it applies to direct hot-water heating instead of steam; it has been made up from figures taken from Mr. Gifford's curves and is subject to the same minor inaccuracies of reading as mentioned in connection with Table III.

TABLE VIII. SQUARE FEET OF DIRECT HOT-WATER RADIATION SUPPLIED BY MAINS OF DIFFERENT DIAMETER.

Friction Head per 100 Ft.	Diameter of Pipe, in Inches									
	4	5	6	7	8	9	10	12	14	16
1.25	7,000	13,000	22,000	30,000	45,000	58,000	80,000	120,000	150,000	215,000
2.50	11,000	20,000	33,000	45,000	65,000	85,000	115,000	175,000	215,000	325,000
3.75	14,000	24,500	38,000	55,000	82,000	196,000	142,000	220,000	260,000	.....
5.00	16,500	29,000	45,000	65,000	94,000	125,000	160,000	260,000	305,000	.....

Comparison of this table with results found by the methods of computation previously given shows that either a greater temperature drop in the circuit or a somewhat lower radiator efficiency has been allowed by Mr. Gifford in laying out his curves. For example, from Table VIII it is found that an 8-in. pipe will carry 45,000 sq.ft. of radiation with a friction head of 1.25 ft. per 100 ft. of length. By the method given by the writer, 45,000 × 0.024 = 1080 gal. of water must be circulated per minute, which, from Table VII, will require a friction head of approximately 2.2, or nearly twice that given by Table VIII. If the temperature drop were increased 50 per cent.—that is, to 30 deg., which is well within practical limits—the quantity of water to be circulated would be reduced to 1080 ÷ 1.5 = 720 gallons.

Referring again to Table VII, we find that an 8-in. pipe will carry 700 gal. with a friction head of 1.1 ft., which is slightly less than that given in Table VIII for the same conditions. This goes to show that while the two methods of computation, as they stand, do not give identical results, they may be brought in accord by small changes in assumptions which are well within good engineering practice.

Painting Power-Plant Apparatus Distinctive Colors

By T. W. Reynolds

ONE little realizes how pleasing is the appearance of power-plant apparatus when painted with distinctive colors, until he has seen such an installation. This is particularly true where the nature of the contents or service of each pipe is noted by means of distinguishing colors. In such instances the color scheme should be extended to include and brighten up the connecting apparatus, otherwise the latter will present a somber hue in contrast with the brightness which is all above and at the ceiling.

There is an element of psychology present; the old second-hand engine with a new coat of paint in varied colors does not seem to offend with so many difficulties; the surroundings being neat and cheery, there is a tendency to maintain and operate with a greater degree of efficiency. The engineer takes increased pride in upkeep and finds his superior the more willing to grant necessary changes. Moving parts stand out with clearness, so that the conditions are safer.

Machine accessories, such as drip pans and oilers in varied shapes and sizes, detract from the appearance of the machine to which they are a necessary adjunct. Their indiscriminate use without some method of concealment is not consistent where the machine manufacturer has carefully designed his product with harmonious lines. Except for brass oilers, each drip pan and oiler should have a fixed location upon some part of the machine and should be painted to harmonize with its location. Where this is done, they are more apt to be returned to their proper position as soon as they have served their purpose. An oiler painted red with a green spout and cover becomes attractive; an unsightly drip pan the more so.

It will usually be found that these appliances will be kept in a clean condition as will also the recesses in the foundation and other places subject to oily drippings. Dirt and grease are the more conspicuous, whereas the implement becomes the less so. The writer found the latter to be true in connection with an inventory. It became necessary to go carefully over each machine to make certain that all accessories had been listed, and this only where some color scheme was in use.

As a suggestion for treatment by this method, consider an air compressor of the cross-compound duplex type. Colors may accord with opinions, but doubtless the following will be found available and serviceable: Paint the foundations and bedplate black, also the steam cylinders, using green for the air ends. Brass piping and parts should, of course, not be painted. The overhead intercooler should be red with flanges painted black, valve rods in green with connecting bell cranks red. Other working parts should be red, such as the governor. A pipe-rail guard at the flywheel painted black with fittings showing white is in keeping; in fact, it is the breaking of continuity in color that is so restful to the eye.

Connecting pipes may have their own distinctive colors when above the elevation of the machine; below that point they should be of the same color as their immediate surroundings. Concrete foundations may be smoothed out with a thorough application of paint so that the interstices are not as noticeable. A good practice in the painting of pumps is to make the water end green and the steam end black. Tanks are usually painted black.

There seems to be no particular necessity for standard distinguishing colors in small piping systems. At one time there was considerable discussion about this method, and it is most certainly a necessity in extensive pipe systems and in pipe subways where complications would soon result from working on the wrong pipe. It would seem that to paint all piping in the boiler room black is sufficient, for these are the larger sizes; cheeriness may be added by the use of a bright red on the brickwork of boiler settings.

The Electrical Study Course—Electric Motor

Two theories upon which the operation of the electric motor may be explained are taken up in detail. The similarity existing between motors and generators is discussed.

IT HAS been found that when a current is passed through a conductor that is located in a magnetic field the conductor will be urged to move in a direction at right angles to the direction of the field. This effect was shown to be due to the lines of force that circle around the conductor itself while current flows through it. Thus in Fig. 1 the conductor is urged to the left, because the lines of force which circle around it strengthen the field of the magnet on the right side and weaken it on the left side. Since the lines of force may be considered to act much as stretched rubber bands, the conductor will be impelled to move toward the left. It is therefore evident that we have here a means of converting electrical energy into mechanical energy, and in fact it is upon this very principle that the electric motor operates.

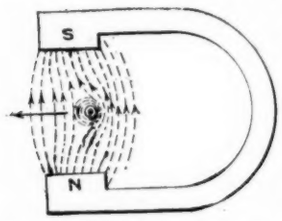


FIG. 1. MAGNETIC FIELD DISTORTED BY AN ELECTRIC CURRENT

Consider an armature such as is used in a shunt generator, Fig. 3, to have current passed through it after the field coils have been connected to the mains; then there will be a number of current-carrying conductors situated in a magnetic field, all of which will tend to be moved across the path of the field. If the forces impelling them are all in the same direction, they will cause the armature core on which they are mounted to revolve. Whether all the forces are in the same direction or not depends on the relative direction of the field flux and the current through the armature conductors. The direction of the force on any conductor can, as previously described, be determined by the finger rule, as illustrated in Fig. 2. The relative direction of the magnetic field and current will depend on the position of the brushes on the commutator. It will be found that, theoretically, the brushes should be on the neutral axis for proper operation, exactly as was found in the case of the generator.

In Fig. 3 the direction of the current in each conductor above the neutral axis is away from the observer, and in each of those below this axis the current is toward the observer. The direction of the field in each case is upward, consequently every conductor above the neutral axis will tend to move to the right and every one below this axis will tend to move to the left, the consequence being that the armature will be made to revolve in a clockwise direction.

Should the brushes be moved to the position shown in Fig. 4, the armature will refuse to rotate, for then the direction of the current in the armature conductors between *a* and *b* and those between *a* and *d* will be toward the observer, and they will be impelled to the left. One set of these conductors will therefore tend to revolve the armature in a counterclockwise direction and the other in a clockwise direction. Likewise the current in conductors between *c* and *b* under the S pole is away from the observer, and in those between *c* and *d* under the N pole is up through the plane of the paper. Hence we have conductors between *a* and *b* and between *c* and *d* producing counterclockwise rotation, and those between *b* and *c* and between *d* and *a* opposing them with an equal force in the opposite direction; consequently there can be no motion.

For intermediate positions of the brushes, as in Fig. 5, the total number of conductors tending to move in one direction will be greater than the total number tending to move in the other direction under the same pole, consequently there will be rotation in the direction of the greater force. The nearer the brushes are to the neutral axis the greater the force becomes until exactly at the neutral axis the force is at a maximum.

From the foregoing it is evident that a shunt generator could be used as a motor. The same holds true for all the other types of generators, and as a matter of fact, whether a dynamo-electric machine is called a generator or a motor depends largely on the nameplate. We might take a generator, remove its nameplate and replace it with one specifying a slightly different rating, and we would have a motor of the same type. If the generator were a compound one, the motor would be a compound motor, etc.

As in the case of generators, it will be found that the practical operation of motors is not quite so simple as the theoretical, or rather the ideal, operation outlined. The chief cause of trouble is commutation, and this as well as other practical considerations that enter into the design and operation of motors will be treated of in a subsequent lesson.

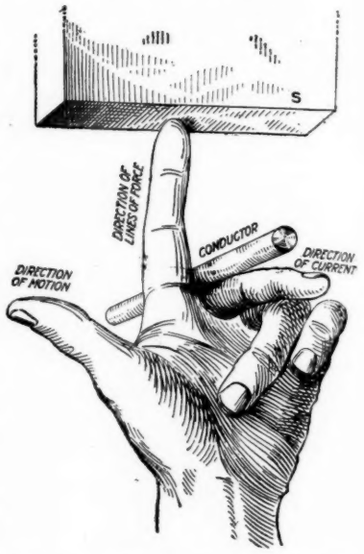
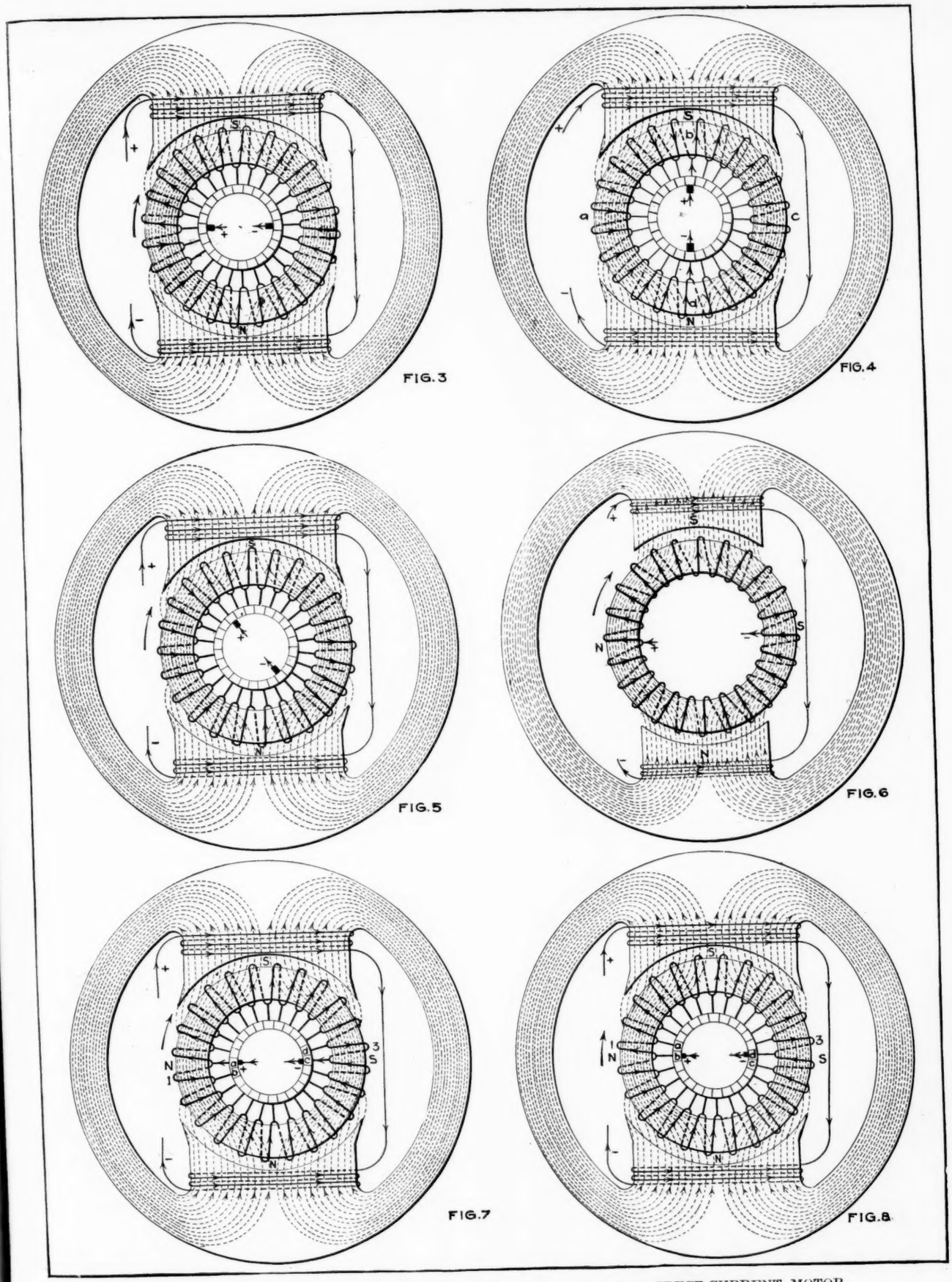


FIG. 2. LEFT-HAND RULE FOR DIRECTION OF MOTOR ROTATION

Before entering upon the practical side of the subject, it will be interesting to discuss a theory which is different from the one already given, and which explains why a motor operates, quite as well as the foregoing theory, although based upon entirely different considerations. In the lesson of July 2 it was found that N and S poles are developed in the core of an armature when current is passed through its conductors. We therefore have an iron ring with a north pole located at one part of its circumference and a south pole situated diametrically opposite it.

If such a ring were to be placed between the poles of a magnet, as shown in Fig. 6, there would be an



FIGS. 3 TO 8 INCLUSIVE. ILLUSTRATING THE OPERATION OF A DIRECT-CURRENT MOTOR

attraction between the north pole of the magnet and the south pole of the ring; also between the south pole of the magnet and the north pole of the ring. Therefore, if the ring were free to turn, it would revolve until its north pole was directly under the south pole of the magnet and its south pole directly under the north pole of the magnet.

It will be noted that a ring such as the one under discussion is identical with the ring armature in Figs. 3 to 5. If taps from the winding are connected to the bars of a commutator, we have an armature as shown in Fig. 7. If the brushes are on the neutral axis as in the figure, we will have poles N and S in the armature when current flows through it. Consequently it will begin to turn in a clockwise direction. So long as the brushes rest on the commutator bars *a* and *c*, the direction of the current through the windings remains unchanged, hence the N and S poles remain fixed in the ring and turn with it.

Fig. 8 shows their position when the commutator bars *a* and *c* have left the brushes and bars *b* and *d* have made contact with them. At the instant when this change occurs, the current in coils 1 and 3 is reversed and the N and S poles of the armature are instantaneously transferred backward through a space equal to that occupied by one armature coil, so that they are again opposite the brushes as in Fig. 7. This action occurs every time a commutator bar passes a brush, the result being that the armature is actuated by a continuous stream of impulses following one another in rapid succession and causing it to rotate.

Although ring armatures have been used in the foregoing description for the sake of clearness, the theories advanced apply equally to drum-type armatures, since N and S poles are formed in them precisely as in ring armatures. The first theory presented, that based on the motion of a conductor in a magnetic field due to the current being passed through it, is the more fundamental of the two, but the second one, that based on the attraction of magnetic poles, is extremely convenient and is a considerable aid in coming to a thorough understanding of the principles involved.

In the first problem given in the last lesson it is required to find at what value a circuit-breaker should be set, or what size fuses should be used, to protect a 75-kw. 120-volt generator if the load is to be limited to 120 per cent. of normal.

The normal load in watts would be the normal load in kilowatts multiplied by 1000 (since there are 1000 watts in a kilowatt) or $75 \times 1000 = 75{,}000$ watts.

The normal current would be the normal load in watts divided by the voltage of the generator, or $\frac{75{,}000}{120} = 625$ amperes. If the load is to be limited to 120 per cent. of the normal value, the current would be 1.2 times the normal current, or $1.2 \times 625 = 750$ amperes. The circuit-breaker would therefore have to be set for 750 amperes, or fuses of that capacity be used.

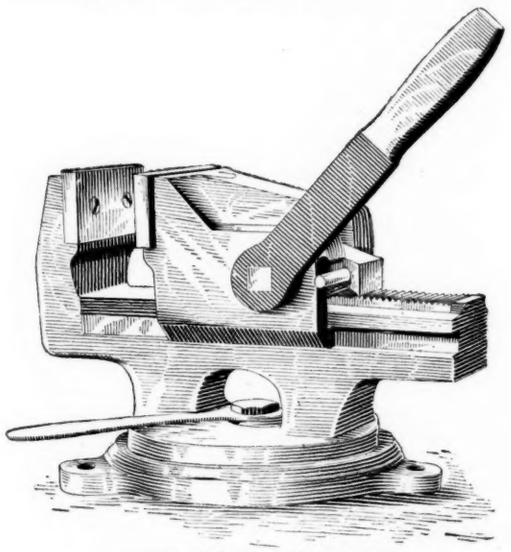
In Problem 2 a generator supplies 750 amperes at 130 volts while operating at 89 per cent. efficiency. How many horsepower would be required to drive it?

The load supplied by the generator, expressed in watts, would be the current which it delivers multiplied by the voltage, or $750 \times 130 = 97{,}500$ watts. If it operates at 89 per cent. efficiency, 97,500 watts must be 89 per cent. of the power required to drive it. If W represents the power required to drive the generator, we have $0.89\ W = 97{,}500$ watts, from which $W = \frac{97{,}500}{0.89} = 109{,}550$ watts. Since there are 746 watts to one horsepower, the power required to drive the generator is the power in watts divided by 746, or $\frac{109{,}550}{746} = 147$ hp. (nearly).

A 1000-kw. 120-volt compound-wound generator furnishes current to a lamp load at a distance of $\frac{3}{8}$ mile and is adjusted to maintain constant voltage at the load. The voltage drop in the line at full load is designed to be 10 per cent. of the normal voltage. What size wire is required if 2100 forty-watt lamps are turned on? What percentage of its full-load capacity would the generator be delivering? What would be the voltage at the generator? What would be the watts loss in the line? What percentage of the load supplied would the line loss be?

Winans' "New Idea" Vise

The illustration shows the general characteristics of the Winans' "New Idea" bench vise, manufactured by the Barnett Foundry and Machine Co., Irvington, N. J. It will be seen that the old-fashioned screw and lever have been replaced by a pawl and rack, actuated by



"NEW IDEA" BENCH VISE

a handle on an eccentric shaft which will exert a pressure many times that possible with a screw.

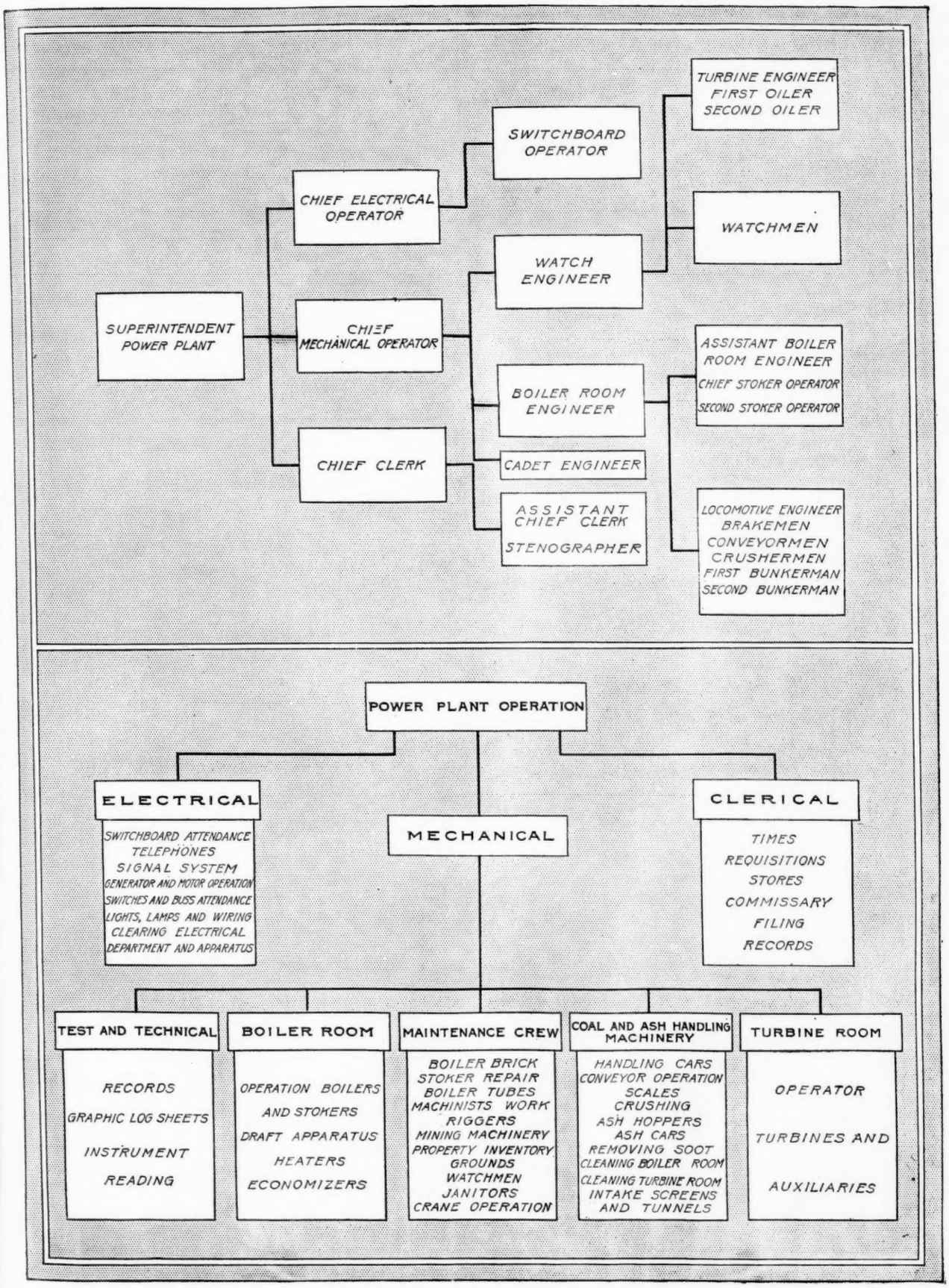
The adjustments from zero to maximum are made with one sliding movement. The pawl eccentric and sliding jaw form a toggle joint, bringing the greatest pressure to bear on the top part of the jaws, causing the work to be clamped tightest at the working part. The moving member slides away from the operator, and there is no handle between him and the vise. The gripping plates are hardened and ground, and the rack and pawl are also of hardened steel.

A valuable feature is that the whole vise may be removed from its swivel base and taken to a surface plate, drill press or milling machine.

This vise is made in standard sizes of jaws from 3 to 8½ in., and with openings of 3¼ to 12 inches.

Organization Charts, Buffalo General Electric Company, Buffalo, New York

Shows how the forces are organized in this power station and what duties each department performs.



Co-operation of Public-Service and Isolated Plants

By Ira N. Evans*

THE nature of the question raised by Mr. Alt in the May 28 issue of *Power* on the writer's article in the issue of Apr. 23 would indicate either a lack of clearness on the part of the author or that Mr. Alt did not read farther than the first page.

The statement at the beginning of the article was a generalization of the following facts based on the concrete examples cited, and was given to enable a busy reader to make an approximate mental estimate of the possibilities in any given case. The points in Mr. Alt's criticism will be taken in order and an effort made to correct his errors of assumption.

There are other localities besides New York in the United States, and while 200 heating days would apply there, it would not hold true for Detroit, although the text did not distinctly state the locality.

The hours in Cols. II, III and IV of Table I (reproduced from the previous article) were compiled from weather-bureau records for the Detroit district, and would require modification for any other locality. Table II gives the details from weather-bureau reports for each month and period used in the article. The next error of assumption is that 18 hours per day constitutes the heating period, as in Detroit heating plants are operated continuously from Oct. 18 to June 18, night and day. The assumption of 18 hours might hold for small installations, but where there is found 50,000 to 300,000 sq.ft. of radiation with underground mains, it would require several men and tons of fuel to start the heating system after a shutdown as well as additional boiler power. This would be especially true if the initial heat required for the iron radiation is taken into account, which would be about seven times the rate required after the system comes to a working temperature. In addition, there would be the necessary replacement of heat due to the cooling of the building and contents. Some of the heating surface may be shut off at night, but it is a well-known fact that fuel is saved and boiler horsepower conserved by continuously operating large heating plants as against intermittent operation. This would be especially true of a hot-water heating system where the medium would have to be raised to the necessary working temperature in addition to the items aforementioned.

TABLE I. POWER RECOVERABLE FROM HEATING FUEL IN INDUSTRIAL PLANT WITH 1,000 BOILER HORSEPOWER FOR HEATING IN ZERO WEATHER

I Outside Temp. Periods Deg. F.	II Hours Nights, Holi-days	III Hours Work Days	IV Total Hours Each Period	V Steam per Hour Lb.	VI Vac., In. Hg.	VII Av. Water Temp., Deg. F.	VIII Turbine Rate, Lb. per Kw.-Hr.	IX Recov. Power Heating Steam Kw.	X Recov. Power Non-Cond. Engine Kw.	XI Turbine Rate Const. Load 900 Kw. Lb.	XII Gross Load Carried Kw.	XIII Net Load Carried Kw.	XIV Evap. Factor 175 Lb. 100 Deg. F. & A. 212 Deg.	XV Steam per Hr. Power Heating F. & A. 212 Deg.	XVI Total Steam Power Heating F. & A. 212 Deg.	XVII Total Steam for Heating
0–10	211	97	308	30,000	3	194	31.4	956	857	31.4	956	856	1.134	34,041	10,484,628	9,240,000
10–20	566	251	817	26,600	9	182	28.4	937	760	28.4	937	837	1.134	30,176	24,653,792	21,732,200
20–30	719	423	1,142	23,300	14	170	26.2	889	665	26.2	900	800	1.134	26,740	30,537,080	26,608,600
30–40	766	354	1,120	19,800	20	154	22.8	870	565	22.6	900	800	1.134	23,065	25,832,800	22,176,000
40–50	622	290	912	16,200	24	135	20.2	802	463	19.8	900	800	1.134	20,208	18,429,696	14,774,400
50–60	475	271	746	14,100	26	115	18.8	750	403	18.0	900	800	1.134	18,371	13,704,766	10,518,600
60–70	423	364	787	12,000	27	110	18.8	638	343	17.0	900	800	1.134	17,350	13,654,450	9,444,000
															137,297,212	114,493,800
	3,782	2,050	5,832										Tons of Coal (Evap. 8 Lb.)..		8,581	7,156
													Cost of Power 1,425 Tons....		.....	.....

Note—Column IX = Col. V ÷ Col. VIII; Col. X = Col. V ÷ 35; Col. XIII = Col. XII — 100; Col. XV = Col. XII × Col. XI × Col. XIV; Col. XVI = Col. XV × Col. IV; Col. XVII = Col. V × Col. IV.

TABLE II. NUMBER OF HOURS FOR EACH 5- AND 10-DEGREE PERIOD OF OUTSIDE TEMPERATURE FROM 0 TO 60 DEGREES DETROIT, MICH.

Work-Day Periods

Month	Days, 7 a.m. to 5 p.m. 0 to 5	5 to 10	10 to 15	15 to 20	20 to 25	25 to 30	30 to 35	35 to 40	40 to 45	45 to 50	50 to 55	55 to 60	60 up	Nights, 5 p.m. to 7 a.m. 0 to 5	5 to 10	10 to 15	15 to 20	20 to 25	25 to 30	30 to 35	35 to 40	40 to 45	45 to 50	50 to 55	55 to 60	60 up
Oct.	....	....	....	....	....	....	2	3	15	17	26	31	42	124	....	....	....	....	....	10	10	21	31	35	73	44	140
Nov.	....	....	....	4	27	25	31	36	43	31	28	9	16	....	....	....	28	28	29	43	83	55	47	28	6	3
Dec.	6	18	32	26	43	31	39	35	....	....	16	4	....	19	42	32	30	38	64	77	22	3	2	20	1	....
Jan.	20	30	15	30	40	60	26	25	4	....	....	....	....	9	20	30	40	56	80	73	32	10	....	....	....	....
Feb.	....	16	35	50	52	41	39	10	5	2	....	....	....	4	35	51	83	74	47	45	11	....	....	....	....	....
Mar.	....	7	28	31	52	47	35	28	17	5	12	8	....	....	18	46	68	44	50	51	64	21	9	7	....	....
Apr.	....	....	....	....	....	3	8	21	37	31	41	19	90	....	....	....	....	1	20	27	47	62	34	30	14	115
May	....	....	....	....	....	....	....	3	25	47	29	32	134	....	....	....	....	....	....	1	30	82	81	97	25	62
	26	71	110	141	214	209	181	173	148	142	157	114	364	32	115	159	249	241	300	327	310	264	208	255	90	320
	97		251		423		354		290		271			147		408		541		637		472		345		320
	1,686 Hours, 0° to 60° Days													2,550 Hours Nights 0° to 60°												
	4,920 Hours																									

Holiday and Sunday Periods

	Days 7 a.m. to 5 p.m. 0 to 5°	5 to 10	10 to 15	15 to 20	20 to 25	25 to 30	30 to 35	35 to 40	40 to 45	45 to 50	50 to 55	55 to 60	60 up	Nights 5 p.m. to 7 a.m. 0 to 5	5 to 10	10 to 15	15 to 20	20 to 25	25 to 30	30 to 35	35 to 40	40 to 45	45 to 50	50 to 55	55 to 60	60 up
Oct.	....	....	....	....	....	....	....	1	7	2	....	10	30	....	....	....	....	....	....	....	3	11	1	3	26	26
Nov.	....	....	....	....	4	6	1	5	13	7	9	5	....	....	....	....	5	2	2	6	9	21	10	12	3	....
Dec.	4	8	13	9	7	3	10	6	....	....	....	....	....	11	13	21	10	1	13	4	11	....	....	....	....	....
Jan.	10	5	10	13	10	6	4	2	....	....	....	....	....	4	6	7	17	16	16	11	7	....	....	....	....	....
Feb.	....	....	6	5	12	11	6	....	....	....	....	....	....	....	3	14	18	11	10	....	....	....	....	....	....	....
Mar.	....	....	2	4	6	10	2	6	9	1	....	....	....	....	....	....	4	12	16	2	8	14	....	....	....	....
Apr.	....	....	....	....	....	....	6	4	4	8	3	6	19	....	....	....	....	....	4	12	3	13	15	2	11	10
May	....	....	....	....	....	....	....	....	....	1	4	16	19	....	....	....	....	....	....	....	....	4	19	16	8	9
	14	13	31	31	39	36	29	24	33	19	16	37	68	15	22	42	54	42	61	35	41	63	35	33	48	45
	27		62		75		53		52		53		68	37		96		103		76		98		81		45
	322 Hours 0° to 60° Holidays													491 Hours 0° to 60° Holiday Nights												
	926 Hours Holidays																									

1,686 + 364 = 2,050 hours days. 2,550 + 320 + 322 + 68 + 491 + 45 = 3,796 hours nights.
Holidays: Sundays, New Year's, Decoration Day, Thanksgiving, Christmas.

*Engineer, Johnson, Larsen & Co., Detroit, Mich.

The period of engine operation for power in all plants is from 1 to 1½ hours greater than the period of shop operation, and many plants in this locality operate the 24 hours for power, the heavier load occurring from 7 a.m. to 5 p.m. With a 9-hour day the period of engine operation would be from 10 to 10½ hours per day, although a reduced period for power would make the proposed arrangement more advantageous, as the net amount returned to the Edison mains would be increased. These are actual operating facts as applied to this locality, where fewer hours are required than in many other cities and industries.

The reduction of the heating period from 24 hours to 18 hours for the class of plant under consideration, as well as the assumption of a 9-hour day for the engine plant instead of 10 hours per day, are fallacious assumptions. Fifty per cent. of the heating steam for zero weather is an incorrect average for the season inasmuch as the minimum steam consumption of any low-pressure steam system will seldom be less than 50 per cent. of the maximum, even if used in summer, and with a well-regulated hot-water system seldom less than 40 per cent. If averages were used, the proper amount would be nearer 75 per cent. of the maximum than 50 per cent. The actual amounts for the different periods are given in Col. V, Table I.

The 1000 hp. in boilers referred to rated horsepower, and as the statement was generalized and only approximate, the heat-unit calculation is hairsplitting.

Regarding the water temperatures, they are given in Col. VII, Table I, the vacuum in Col. VI, and in Col. VIII are the manufacturers' guaranteed turbo-generator rates for 80 per cent. power factor, all of which are based on actual experimental data in possession of the author.

Averages cannot be used in calculations for total steam and fuel consumption in cases of this character. Erroneous conclusions are generally the result of such methods, as instanced by Mr. Alt's difficulties.

The assumed steam conditions for power are given with the evaporation factor in Col. XIV, Table I, as 175 lb. and 100 deg. superheat, and with the vacuums and turbo-generator rates given in Cols. VI and VIII Mr. Alt's elaborate estimate of steam consumption by means of percentages becomes entirely unnecessary and, as would be expected, erroneous.

A careful perusal of the entire text and Table I will answer most of the questions as to steam consumption and power recovery and will indicate that Mr. Alt has considered only the generalized statement instead of the concrete examples cited. Table I applies to the first plant cited, where 1600 hp. in boilers are operated more or less through the entire year and 30,000 lb. of steam is required for heating in zero weather on a hot-water system, although the plant is at present heated by reduced live steam at about 5 lb. pressure. With hot water they should use about 7200 tons of coal per year for heating. They actually purchased 9000 tons in 1916.

The actual power recovery is shown in Col. IX to vary from 956 to 638 kw., and as stated at the top of page 584 of the previous article, the constant power recovery is slightly disarranged owing to the superheat causing increased recovery in zero weather. It was deemed advisable to use 900 kw. gross constant load instead of 800 kw., adding the additional fuel for the additional power in the warmer periods. This difference between Col. XVI and Col. XVII is 1425 tons at $5, or $7125, which item is what puzzles Mr. Alt.

Col. XIII shows the net recovered power load with 100 kw. deducted for plant purposes and circulating pumps. If this plant was a well-designed hot-water plant, as in the case of No. 3, 1425 tons would be required in addition to the heating fuel for the addition to the power generation. In the first case, by changing over to hot water, the total power recovery and heating would require about 1000 tons less than they are actually using for the present heating system.

To make the next statement clear, a reiteration of the purposes of the article will be necessary. It is the intention to purchase all current in the same manner as at present. The existing power plant for heating, labor, boilers, fuel and auxiliaries will be utilized and operated as at present. A turbo-generator will be installed and operated by the heating steam raised to a high initial pressure, of a size to just balance the heating steam, and operated night and day from fall until spring. The current from this unit will be metered into the Edison mains independent of any current purchased for plant purposes and form the basis of the amount of power and money saved, which would be divided as mutually agreed between the public-service company and the owner.

The heating system then functions simply as a condenser for the turbo-generator, the variation of the vacuum producing the different requirements in total steam for various outside temperatures to keep the buildings at a constant temperature with practically a constant power load. The entire problem would vary with locality and length of the heating season and size of plant, but the generalized statement aforementioned would still hold. It might be desirable to use superheated steam, in which case the power load recovery and the size of the turbo-generator would be reduced. The turbo-generator thus becomes virtually a substation of the Edison Co., utilizing the heating-boiler plant and fuel of the owner.

Mr. Alt questions the 2 lb. of coal per kilowatt-hour for central-station current, which is again Detroit and not New York. He is taking issue with Alex Dow, president of the Detroit Edison Co., who claims 1½ lb. per kw.-hr., or 0.375c. per kw.-hr. as the present cost of fuel. If the coal required was 3.22 lb. per kw.-hr., stated by Mr. Alt, and the price $5.50 per ton, the cost of fuel per kilowatt-hour would be $\frac{550}{2000} \times 3.22 = 0.885$c.

The public-service company sells current here for 0.95c. to many large consumers. At the above cost for fuel this would be hardly possible even for a philanthropic public-service corporation.

Summarized, Mr. Alt's assumptions are:

1. Reducing the heating period from 24 hours to 18 hours.

2. Arbitrarily assuming half the maximum heating steam as the hourly requirements throughout the season as the steam available for power and heating.

3. Errors in calculating the turbo-generator rate by means of percentages rather than using actual guaranteed rates.

4. Using half the heating steam as an average, yet

maintaining the maximum size for the turbine called for under maximum conditions. The machine should be reduced to 500 kw. under these assumptions, reducing the investment by one-half.

5. Charging auxiliaries against the proposal that they are already in operation on the heating plant; also deducting another percentage for pumps when it has already been taken into consideration.

6. Crediting current at 1c. per kw.-hr. when the fuel used would be nearly double according to his statements, although the cost of current would have to be more and the return and saving increased.

It is again suggested that Mr. Alt read the article, especially the last part, with greater care.

Maintaining Constant Frequency

It is decidedly easier for the operators and better for the customers of two or more power companies that are interconnected a part of the time, if exactly the same average frequency is maintained when they are operated independently. It is a fact that ordinary frequency meters are neither sensitive enough nor accurate enough to enable the average value of the frequency to be maintained exactly correct. A new method has been developed by the Warren Clock Co., Ashland, Mass., which enables the frequency to be held at exactly its true average value. It consists of a Warren master clock which is located near the switchboard and within view of the operator on duty. This clock contains two complete movements, one accurately controlled by a pendulum, having an Invar rod and dead-beat escapement, and the other by a Warren self-starting synchronous motor, Fig. 2. There are two second hands on the large upper dial of the clock, which is 5 in. in diameter. One of these hands is black and connects with the pendulum so that it registers true time and can be depended upon to run within one-half second per day when properly regulated. The other second hand, mounted on the same center and revolving over the same dial, is gold color and receives its motion from the synchronous motor. The motor requires only two watts to operate it and is connected to an instrument transformer which is always in circuit. Therefore the gold second hand on the master clock integrates or counts the alternations of the current, since it is directly geared to the synchronous motor, or in other words, this gold hand moves at a rate depending entirely upon the frequency of the current.

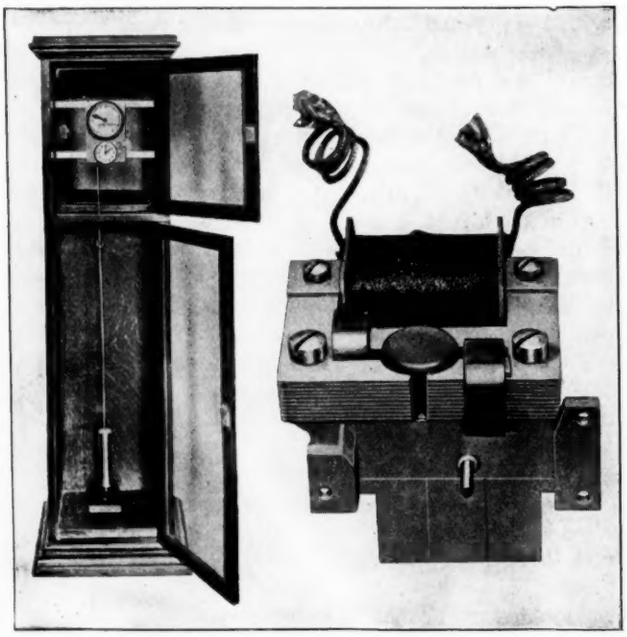


FIG. 1. MASTER CLOCK

FIG. 2. SELF-STARTING SYNCHRONOUS MOTOR

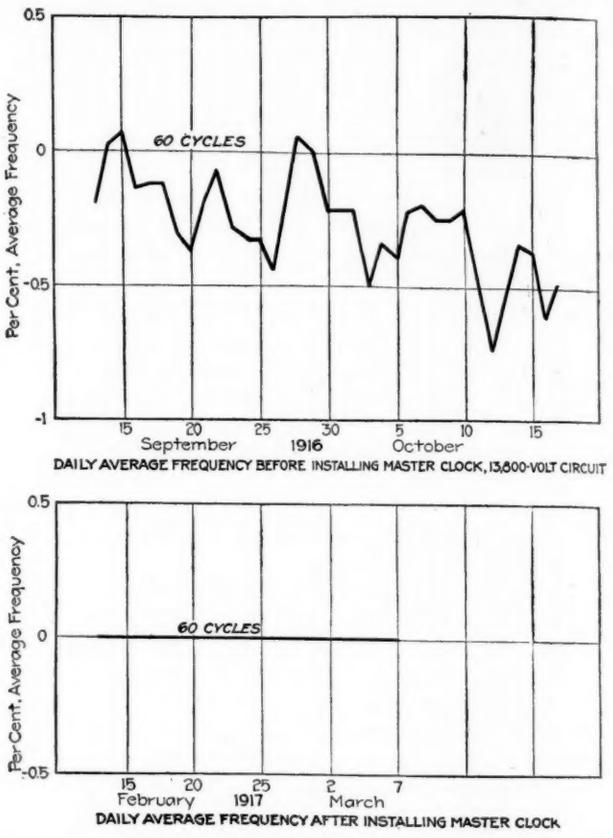


FIG. 3. AVERAGE FREQUENCY BEFORE AND AFTER INSTALLING MASTER CLOCK

If the average value of the frequency is exactly normal, the gold hand will move just as fast as the black hand and they will constantly remain together. If the frequency is above normal the gold hand will keep gaining over the black hand, and conversely, if the frequency is low the gold hand will lose and fall behind the black hand. The operator on duty can then adjust the speed of the turbines from time to time by means of the speed-control switches if he finds that the gold hand on the clock is tending to go ahead of, or behind the black hand.

Experience has shown that in a large power station the frequency will, when once adjusted, remain very close to its true value, and the gold hand on the clock will not deviate from the black hand more than a second or two in a half-hour. Therefore it is not necessary for the operator to make as frequent adjustments as he has been accustomed to do with ordinary frequency meters.

With the master clock in use, corrections are not made unless there is a positive and long-continued tendency for the frequency to run high or low. Momentary fluctuations in frequency are not apparent at all on the

dial of the clock. The master clock is kept wound at constant tension by the same motor that drives the gold hand. Thus no attention whatever is required from the operator except to check up the clock from day to day, preferably by comparison with Washington time signals, and to regulate it occasionally. It has been found in practice on large systems that when the frequency is controlled in this manner, its average value as measured over a 24-hour period can be easily held within one five-hundredth of one per cent. of its true value and this result is independent of temperature. Obviously, any number of power stations that are thus controlled can be joined together without the least disturbance.

At the top of Fig. 3 is shown an irregular curve, recording the average daily frequency for a period of one month, in 1916, on the Boston Edison system before the master clock was installed, and the straight horizontal line below shows on exactly the same scale the daily average frequency during the month after the master clock was installed. This same horizontal line is maintained month after month without showing any deviation great enough to be visible on this scale.

Risk Assumed by Fireman of a Power Plant

Plaintiff was employed to fire and look after boilers in the power plant of a factory. In the course of his duties he went to the top of a boiler to open a valve, using a ladder placed against the boiler for the purpose. Opening of the valve caused water to flow onto the floor where the ladder stood, and resulted in slipping of the ladder and consequent injury to plaintiff when he attempted to descend from the top of the boiler.

The plaintiff had been employed in the plant for several months, and had been informed that the ladder could not be safely used when the floor was wet. Under these circumstances, it is held by the Kentucky Court of Appeals in the recent case of Moorman vs. P. Bannon Pipe Co., 199 Southwestern Reporter, 802, that plaintiff assumed the risk of the accident resulting in his injury. The court reaffirms the general rule of law that the liability of an employer for injuries resulting from failure to use reasonable care to make his employees' places of work reasonably safe is qualified by the duty of employees to guard themselves against obvious dangers. Says the court:

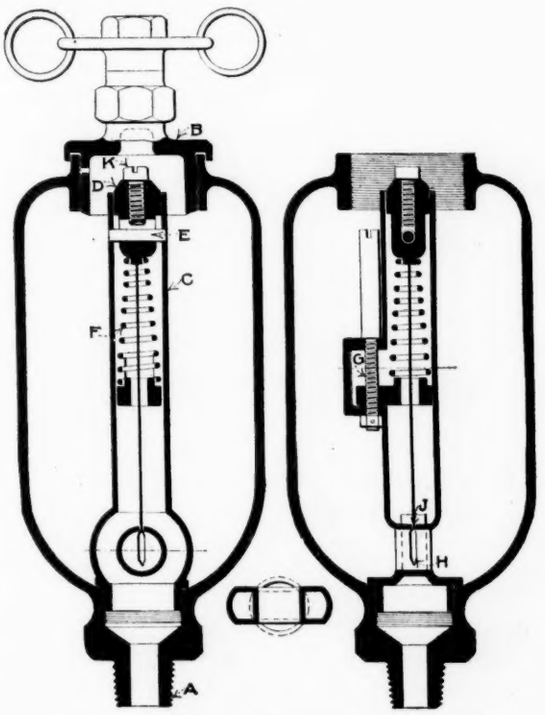
> If the servant has equal knowledge of the facts and conditions with the master of the defects and dangers therefrom, and they are appreciated by him, or if they are so obvious that an ordinarily prudent person situated as the servant was would have observed and appreciated them, then the master will be relieved of liability.

Johnson Graphite Lubricator

The object of feeding graphite to the cylinder of an engine or pump is to improve the lubrication so as to produce easily moving valves with a decreased strain on the valve gear; the wear of the piston rings and cylinder walls is also reduced. Graphite is not only of advantage in the lubrication of steam engines and pumps, but it is equally available for compressors and gas-engine lubrication.

As is well known, graphite cannot be fed through the ordinary oil lubricator because it settles in the bottom of the container and clogs the oil passages. As a result many special feeding devices have been designed. One of these is the Johnson graphite lubricator, manufactured by the Johnson Lubricator Co., 30 Church St., New York City.

The graphite container is made with a threaded projection *A* at the bottom, which is screwed into the steam pipe close to the throttle of the machine to be lubricated. At the top is a filling plug *B*. On the interior of the lubricator casing is a piston casing *C*, with a movable piston *D* through which the pin *E* passes; a slot in the piston, however, permits a slight up-and-down movement. Below the piston is a spring *F*, the tension of which is adjusted by the screw *G*. From the piston *D* a stiff rod connects with the plug *H* which opens and closes the opening *J*, through which the graphite is fed from the lubricator to the steam pipe.



SECTION THROUGH GRAPHITE LUBRICATOR

When the steam is turned on the lubricator, it fills the interior space at the pressure carried in the pipe line. As the engine, pump, etc., take steam, the pressure drops slightly and the steam in the lubricator forces the piston *D* down against the tension of the spring *F* and moves the plug *H* away from its seat *J*, allowing a small quantity of graphite to be forced out into the steam main. When the engine has ceased taking steam, the pressure in the pipe line builds up to its original point, and is communicated to the graphite chamber, past the piston *D*, which is not steam-tight; and with the pressure equalized, the spring forces the piston up. This movement closes the opening *J* by bringing the plug *H* to its seat. The cycle of events is repeated each time steam is admitted to the engine cylinder. If the piston should vibrate faster than the engine or pump takes steam, it can be made to vibrate with the engine by screwing down on the adjusting screw *K*.

Your Coal Supply Will Depend on Your

The United States Fuel Administration makes the following recommendations concerning the generation and use of power, light and heat. The alphabetical reference to each subject corresponds to the questions in the Questionnaire.

(A) Fuel: That provision be made for weighing and recording of the fuel used each shift or day.

Keep daily record of coal consumption, recording such weights in the boiler room. (See United States Fuel Administration Bulletin on "Boiler Room Accounting Systems"). A low rate of combustion per square foot of grate surface means waste. The coal burned per hour, divided by the grate surface in active use will give pounds of coal per square foot of grate surface per hour. For hand-fired furnaces with soft coal, this figure should not be less than 15 to 20, and for steam sizes of anthracite, 10 to 15. Reduce the number of boilers or grate surface to obtain the proper rate of combustion.

(B) Water: That feed water be heated, measured and regulated.

Keep daily records of feed-water consumption. This, with record of coal, permits calculation of the water evaporated per pound of coal. Use exhaust steam for heating feed water, and save one per cent. of fuel for each 10 to 11 degrees Fahrenheit rise in temperature of the water, also increase steaming rate of boilers. Steady or regulated feed of water is a source of economy.

(C) Air Supply: That provision be made for a correct air supply and a convenient means for the measurement and control of the draft.

Determine the air pressure to the furnace with draft gages, connected to the furnace or breeching. It eliminates guesswork and insures a proper supply for combustion. Regulate draft on all the boilers with main flue damper, after setting individual dampers on each. Check combustion by analyzing the flue gases. Suitable instruments are available at from $15 to $25. By this method admission of excess air may be readily detected, the skill of the fireman known and waste of fuel prevented.

(D) Cleaning and Heating Surfaces: That provision be made to keep boiler surfaces clean inside and out.

Tubes should be frequently and thoroughly cleaned and the feed water properly treated to prevent scale formation upon the inside of the boiler or tubes. (See United States Fuel Administration Bulletin on "Water Treatment for Steam Boilers.")

(E) Boiler and Furnace Setting: That the grates be in good repair, that settings, breeching and access doors be free from air leakage, and that surfaces wasting heat be covered with insulation of ample thickness.

Do not allow burnt-out or broken grates. They waste coal into the ashpit and the surplus air causes holes and clinker. Stop cracks in the boiler setting, door frames, etc., with specially prepared material for this purpose. Badly warped or cracked fire-doors should be repaired or replaced. Air leaks in brickwork and general setting can be detected with a torch. If leakage exists, the flame will be drawn in.

(F) Insulation: That the surfaces of steam piping, drums and feed-water heaters which waste heat by radiation be properly covered with insulating material.

Covering these surfaces with 85 per cent. magnesia or similar material, at least 2 in. thick, will save 80 per cent. of the heat.

(G) Engine Room and Heating Systems: That exhaust steam be utilized wherever possible instead of direct steam from the boilers. The plant should be so designed and operated, so far as possible, that no more exhaust steam will be produced than can be used.

Use exhaust steam for heating feed water, buildings and general process work. Exhaust steam from the engine contains about 90 per cent. of the heat in the live steam. Never allow exhaust steam to escape to the atmosphere when it can be used for any useful purpose and avoid waste.

Compliance With These Recommendations

(H) Supervision: That a committee of employees be detailed on fuel conservation in the boiler and engine rooms and for the work of fuel, power and light conservation outside of the power plant.

Plant owners should appoint an individual or a committee to study conditions in the boiler and engine room and throughout the plant. The duties should be the organization of and carrying out methods for the prevention of waste. The members of this committee to be changed from time to time, and where feasible, some form of bonus arrangement made for those most active in accomplishing results. Records should be kept on a weekly or monthly basis showing just what has been accomplished by the activities of this committee.

The wide variation in conditions surrounding the use of power, light and heat is against any arbitrary rulings governing shop operations. The following points, however, should in a general way be of assistance to your committee:

General Points To Be Observed

First—Eliminate operation of motors when machines are idle, by means of convenient switches.

Second—Group machines, so that driving motors or engines operate at highest efficiency.

Third—See that all bearings are regularly oiled and inspected to correct alignment and insure operation with least friction.

Fourth—Eliminate belt slippage, so far as possible.

Fifth—Stagger manufacturing operations so that peak loads will be flattened as much as possible.

Sixth—In alternating-current installations, provide means for improving the power-factor conditions.

Seventh—Reduce elevator service to a minimum.

Eighth—Reduce use of hot water to a minimum.

Ninth—Stop all leakage in water spigots, pipes, etc.

Tenth—Reduce number of lights used wherever practicable. Reduce candlepower of lights used wherever possible.

Eleventh—Eliminate use of carbon lamps and replace with mazda or other high-efficiency lamps.

Twelfth—Eliminate arc lamps by using large lighting units of more efficient type.

Thirteenth—Provide a thermometer in different parts of the shop and make arrangements to keep the temperature within reasonable limits.

Fourteenth—Eliminate heating radiators or piping not in actual use.

Fifteenth—Wherever possible provide storm doors and storm windows on all openings used during winter months.

Many other ways to effect conservation will, no doubt, be devised by your committee, and it is suggested that emphasis be laid on the fact that no saving is too small to be given consideration.

The Administration has planned an advisory board of competent consulting engineers attached to the office of the State Administrative Engineer, and there will also be attached to his office expert firemen and operating engineers.

Further, the United States Fuel Administration has prepared a fifty-minute film of moving pictures, showing good and bad operation in the steam-boiler plants, methods of testing boiler fuels, etc., which will be exhibited with lectures in all industrial communities. It is also preparing a series of official bulletins written for the purpose of informing boiler-plant operators on the various phases of steam and fuel economies. These bulletins include the following: (1) Boiler and Furnace Testing; (2) Flue Gas Analysis; (3) Saving Steam in Heating Systems; (4) Boiler Room Accounting Systems; (5) Saving Steam and Fuel in Industrial Plants; (6) Burning Fine Sizes of Anthracite; (7) Boiler-Water Treatment; (8) Oil Burning; (9) Stoker Operation.

Further information concerning this publicity and educational work and extra copies of the Questionnaire may be obtained from the State Administrative Engineer.

Zone System of Postal Rates for Periodicals

THE following letter from Hon. Charles E. Hughes to Allen H. Richardson, of the Publishers Advisory Board, 200 Fifth Avenue, New York City, should be of personal interest to every reader of *Power*. Mr. Hughes says:

Dear Sir: In answer to your letter, I beg to say:

I prefer not to accept a retainer to appear before legislative committees upon matters of general policy, as in such matters, if I have anything to say, I desire to speak only as a citizen.

I have no hesitation in saying that I regard the zone system of postal rates for newspapers and periodicals, coming under the definition of second-class mail matter, as ill-advised. The Commission on Second-Class Mail Matter (appointed in 1911), of which I was a member, considered this question and reported unanimously against the zone system. We said in that report:

> The policy of zone rates was pursued in the earlier history of our post office and has been given up in favor of a uniform rate in view of the larger interest of the Nation as a whole. It would seem to the Commission to be entirely impracticable to attempt to establish a system of zone rates for second-class matter. . . .
>
> Progress in the post office, with respect both to economy in administration and to public convenience, leads away from a variety of differential charges to uniform rates and broad classifications.

In my judgment the zone system for second-class mail matter is unjust to the publisher and unjust to the public. It not only imposes upon the publisher the additional rates upon a sectional basis, but it makes necessary the added expense for the necessary zone classifications at a time when every economy in production and distribution is most important. It introduces a complicated postal system to the inconvenience of the publisher and public when there should be a constant effort toward greater simplicity. There is no more reason for a zone system of rates for newspapers and magazines than for letters.

Newspapers and magazines are admitted to the second-class postal rates on the well-established policy of encouraging the dissemination of intelligence, but a zone system is a barrier to this dissemination. If it is important that newspapers and magazines should be circulated, it is equally important that there should not be sectional divisions to impede their general circulation through the entire country.

We are proud at this moment of our united purpose, but if we are to continue as a people to cherish united purposes and to maintain our essential unity as a nation, we must foster the influences that promote unity. The greatest of these influences, perhaps, is the spread of intelligence diffused by newspapers and periodical literature. Abuses in connection with second-class mail matter will not be cured by a zone system of rates. That will hurt the good no less than the bad, and perhaps some of the best sort of periodical literature will be hit the hardest.

We do not wish to promote sectionalism, and "one country" means that in our correspondence and in the diffusion of necessary intelligence we should have a uniform postal rate for the entire country. The widest and freest interchange is the soundest public policy.

I hope that Congress will repeal the provision for the zone system, which is decidedly a looking-backward and walking-backward measure.

Very sincerely yours,
CHARLES E. HUGHES.

Delegates to the National Convention, N. A. S. E.

A man is valuable and well off as much on account of the people that he knows as for the things that he knows.

One of the principal benefits arising from attendance at a convention is the opportunity it affords of extending one's acquaintance; of getting to know a lot of worth-while people and to be known by them.

The trouble is that at a convention one meets so many people all at once that it is impossible to remember them all and associate their names and positions with their faces.

To help in doing this *Power* wants to publish a photograph of each delegate with his name and that of the association which he represents at the coming convention at Cincinnati, Ohio, Sept. 9 to 14.

JOHN DOE
ENGINEER
R. H. ROE & CO.
NEWARK, N. J.

NEWARK, N. J., No. 3. N.A.S.E.

In order to do this for you we must have your photograph. We prefer one of the postal card size showing only the head and shoulders. Will you not send us one of these now so that we may get the engravings made in time for printing ahead of the convention?

Each delegate who gets his photograph and the necessary information to us in time will be presented, upon calling at the *Power* booth, with a package of cards with his picture, position and association as shown above; also with the electrotype.

But in order to do this we must have your photograph, your name plainly written, your position and your association.

You can get several of the kind of photos that we mean for a quarter. Please attend to this now and make it sure for you and easy for us.

Neither the owner of a pumping plant nor a power company furnishing electricity to the plant is liable for the death of an employee of the former, due to coming in contact with electric wires on the roof of the pumping station, where the unfortunate man was expressly warned not to go near the wires and expressly instructed how he could proceed with his work without coming in contact with them. (North Carolina Supreme Court, Murphy vs. City of Charlotte *et al.*, 94 Southeastern Reporter, 299.)

EDITORIALS

The Way To Save Is To Do Without

MONTHS before the United States entered the war, Frank B. Gilbreth, M. E., now Major Gilbreth of the U. S. Engineers, told at a smoker of the American Society of Mechanical Engineers some of his experiences in Germany. One evening he had an appointment at his hotel with an important official of the government. As they passed out into the hall after the interview, the official remarked: "One minute, please—your key." Mr. Gilbreth, wondering what *verboten* act he had now committed, passed over his key and the exalted personage went back and carefully turned out the one electric light that had been left burning.

"We are at war," he said, "and everything counts."

We are at war. There is not coal enough for our homes, hospitals and industries. To burn a bit of coal needlessly, to waste or destroy anything that it requires the burning of coal to make is a crime.

We are at war and coal is scarce. Walk up Broadway in New York or State Street in Chicago in broad daylight and see how many electric lights are burning needlessly and wastefully. In the suburbs notice the gas lights that are allowed to burn far into the forenoon if not all day.

We are at war. Walk up the main street of any large city in the evening and try to count the lights that blazon forth the attractions of the Follies-Burlesque, the virtues of various brands of chewing gum and booze, and emit floods of light from the show windows that line the way.

Notwithstanding the assertions of those who are collecting the money for them that these lights cost very little coal and are necessary to keep up the spirits of the people, they *do* cost in the aggregate a whole lot of coal and teach the people extravagance rather than cheerfulness. The Fuel Administration does well to announce its intention of going after them—and will do better by doing it in earnest.

We are at war and everything counts.

The Shortage Outlook

IN SPITE of strenuous efforts on the part of the coal operators, the railroads and the Fuel Administration to increase the production and accelerate the delivery of coal, each passing week serves to emphasize the unpleasant truth that with the arrival of winter there is going to be an insufficient amount of coal available to supply the war industries, the public-service corporations and the domestic consumers with all the fuel that they need.

There are reasons for this condition of affairs. In the first place, there is a shortage of cars. Many mines have been unable to obtain half of the number of cars needed to carry away their weekly output of coal, with the result that there has been failure to make deliveries in response to the flood of early orders that poured in as a result of the appeals of the Fuel Administration.

Another reason is the shortage of labor. Through the operation of the selective draft, a large number of mine workers were removed from the mining industry. Others were taken away by offers of greater wages in other lines of industry. The result is that the mines are unable to produce enough coal to meet the minimum estimated demand, although they have already surpassed all previous output records.

The necessity of furnishing our own fighters and those of our Allies with ample food supplies to sustain them in their grim and grilling task has enforced the observance of still stricter regulations concerning the consumption of meat and sugar, in order that there may be no lack of these vital rations to seriously handicap the work of our army.

The same situation exists with respect to wheat. The necessity of helping out those whose cause we have espoused makes it imperative that we shall curtail our own consumption of white bread considerably, at least until the new wheat crop comes on the market to end the shortage of that grain.

These and numerous other shortages are actualities and more are likely to come. In fact, shortages form about the only commodity in which no serious shortage may be expected. But as compared with all other belligerent nations our present situation is so much less trying as to be actually fortunate by contrast. And though we may be subjected to inconvenience and privation, we shall meet them with the stoicism of a people who believe in the righteousness of their cause and have unshakable faith in its triumph.

Concentrate Engineering Talent and Experimental Facilities on the War

SELDOM does a week go by without our hearing of some new device or improvement in military machines made by the Germans. Now it is a new gas, again a bigger submarine, then an armored airplane or the long-range gun. Always the improvement or novelty represents an engineering development—*the fruit of the concentration by Germany of all her technical brains on war problems.* One does not need to be told that in this country we are far from using on war work all of our engineering brains or of our laboratory and experimental equipment. Everywhere men skilled in developing mechanisms remain unused; everywhere plants and institutions with facilities for doing good experimental work are allowed to remain idle.

True, we are doing some research work, and there have been excellent results. But we have barely made a beginning. There are important divisions of the war machine doing no development work whatever. Moreover, machinery for expanding development work does not exist. The National Research Council is a coördinat-

ing and advisory body. For greatest effectiveness there must be large development sections in the executive departments themselves. They have the funds, and the development agencies can be used to best advantage when in closest contact with the departments they serve. The Research Council will still be needed as a coördinator; its data on available laboratory facilities and the status of research in the various branches of warfare will be of invaluable assistance.

While, as suggested, there must be close contact between the various departments and their research agencies, it should be clearly borne in mind that there must be a sharp line of demarkation between development work and production. Confusion of development with production has been a blighting curse on much of our army work since April, 1917. The airplane *debacle* was due primarily to such interference. Those who did not understand production were constantly changing designs in an effort to get the very best. Meanwhile, planes were sorely needed in France, and less perfect machines would have been of incalculable value.

Naturally, the formulation of the right plan requires a recognition of the work of present agencies—the Bureau of Standards, the National Research Council, the development groups in various divisions of the war mechine. Best results would seem to be promised were a man of the Schwab or Ryan mold, understanding the function of development and research work as carried on in the great private industries, placed in charge of all development. He would build large, his vision would inspire engineers and scientists to the utmost effort, his energy would bring to bear on war problems, even as Germany has done, all our available engineering talent, all the existing facilities for scientific research.

Could we meet Germany on such a basis our past achievements would warrant us in abiding the result with confidence.

Maximum Fuel-Saving Co-operation Needed

IN the campaign against fuel waste, now countrywide, every feasible agency should be utilized. It is gratifying to see the coöperation between the various state fuel administrations and local engineering authorities, power-plant operating staffs and owners, which is beginning to make itself felt, but the task ahead is a big one and will not be completed in a few weeks or even a few months. Constant vigilance is essential to the maintenance of high operating efficiency. especially in the face of present coal-supply conditions. From the coal passer to the Federal Administrator himself there can be no relaxation in effort if this country is to go through the coming winter without serious disaster to its industries.

This means, of course, that all possible ways must be taken to save coal, and that wherever expert knowledge of combustion processes exists and is available, it should be turned to account for the common good. We believe that in some of the smoke-inspection departments of our cities and states the fuel-administration workers can find assistance of the highest technical value in dealing with these questions of economical operation. Expert knowledge of firing conditions should be mobilized all along the line. Without the least disparagement of the excellent work of the local branches of the United States Fuel Administration, it may be pointed out that there is still an opportunity to be made use of in the more intimate study by smoke-inspection specialists of combustion conditions on behalf of the Government. Smoke prevention symbolizes efficient operation, to begin with; and some of those engaged in this work have made a life-long study of boiler-house practice which ought now to be drawn upon as a matter of course. It is not enough that such an inspection department should be asked to furnish lists of plants which should receive the special scrutiny of the Government fuel authorities and their associated engineers and then be allowed to drop back into their normal routine duties without further consultation. All this is good, so far as it goes, but the pressing need of the day is to save coal by every possible effort, and this is indeed more important for the time being than the smoke problem itself.

Many of the hard-working and patriotic men serving the Federal Fuel Administration in local communities are not possessed of expert knowledge of boiler-plant economy, even though they may be familiar with the commercial aspects of coal supply. There are too many plants in operation to be covered in a short time in a thorough manner by even the most self-sacrificing committee of advisory engineers, and hence, if the smoke inspectors generally can be drafted as it were into the temporary service of the Fuel Administration, the attack on old General Inefficiency will be strengthened and the positive and successful results of the drive will be greatly increased. The work is of direct importance in the conduct of the war, and we hope it will be pushed hard in places where as yet it is not being carried on to maximum advantage.

New rates of postage on magazines became effective July 1. The increases are material, particularly for distances of more than 300 miles from the place of publication. The obvious step would be to raise the subscription rates in distant zones to cover the added postage. For the present, however, the publishers of *Power* have decided not to increase the subscription price, trusting that in the interests of national unity Congress will before long repeal the zone law and restore the universal flat-rate system. Zone rates on magazines obtained in this country before the Civil War, but were abolished in 1863. The publishers hope that they will not find it necessary to increase the cost of the paper to its readers.

The Zone System of postal rates for periodicals is condemned by Hon. Charles E. Hughes, who was the head of the Postal Commission which investigated the Post Office Department several years ago. Read his letter on page 94.

The Marine Engineers Beneficial Association has negotiated a nonstrike agreement with the American Steamship Association and the Shipping Board. Good Work!

There is a lot of good matter in *Power* that is worth saving; but if you save it, you want to know where to find it. Send for the Index. Now ready. Free.

CORRESPONDENCE

Burning Fuel Oil

Letters on the subject of fuel oil are interesting and instructive, and as suggested by L. D. Harris in the issue of May 14, page 704, anything of value pertaining to this fuel should be printed, as it may be the means of helping users to get better results and effect substantial savings. From experience I find among the principal points in fuel-oil combustion that draft regulation and tight brickwork are most important. This is of course true of all fuels, but particularly so with fuel oil. Another important thing is the point of air introduction. This is dependent upon the type of burner, design of furnace, etc., but I find as a rule that too much area is provided on the grates for air to pass up into the furnace. The air should be introduced at a point near the tips of the burners through openings no larger than necessary to furnish sufficient air for the maximum load, which may mean, of course, that the air openings or checker work may extend over considerable area, but the idea is not to have a large opening in the grates near the bridge-wall if the burners are located in the front end of the furnace; for the openings near the bridge-wall would allow cold air that is unnecessary for complete combustion to enter and carry a large amount of heat up the stack.

One thing is sure—the air and oil must be well mixed to get good results. This matter must therefore be considered when designing the checkerwork or air openings on the grates. Firemen often have the idea that when burning fuel oil the dampers must be wide open regardless of the load. This is wrong; the dampers should not be open more than is required for proper combustion and the steam requirement. In some plants explosions have occurred in the furnace or combustion chamber when attempting to light a fire with the damper entirely closed, which is a natural result; but thereafter the fireman, in order to play safe, has made it a point to keep the dampers practically wide open at all times.

It is important, of course, to get a good burner and then to see that the oil is delivered to the burner at the proper pressure and temperature consistent with the gravity of the oil and design of burner. The steam supply to the burners should be so taken from the lines as to insure minimum condensation, and the steam lines should be well insulated and properly trapped to avoid water at the burners. It is a good plan to check the oil consumption for each day by placing an oil meter between the pumps and burner. This meter should have a bypass to supply the burners in case the meter has to be cut out for repairs or adjustment. A strainer should also be provided to protect the meter and burners from foreign matter that may be picked up by the pump suction. Before buying the meter, however, the maximum and minimum oil demand and the pressure and temperature of oil at the meter should be known in order that the meter may be properly calibrated for the conditions under which it is to operate. This is particularly important in regard to the temperature and amount passing through the meter per unit of time.

The oil pump should be in duplicate and have a safety valve connected in each discharge line to prevent excessive oil pressure in case the burners are all shut off at one time or the line should become otherwise plugged up. And as a further protection, a reliable pump governor should be provided to automatically control the pump speed as the requirements vary, and maintain the proper pressure at the burners. Bridge-walls are often the cause of poor combustion. Experiments should be made to determine just what height is required for a given case. The tendency is toward too high bridge-walls, especially under return-tubular boilers. A flue-gas analysis instrument is a good investment where fuel oil is burned and should be used frequently.

Keep the heating surfaces clean of soot and remember that black smoke issuing from the stack not only indicates poor combustion, but also means that the tubes are getting a coat of nonconducting material so that the temperature of the flue gas can be expected to rise under these conditions, causing a further loss in efficiency. Mr. Harris' suggestions relative to high settings and plenty of combustion space are excellent and should be followed wherever possible. C. T. BAKER.

Jacksonville, Fla.

Stopped Sand Hole with Tin Foil

In the plant of which I have charge a 7-in. gate valve on the steam line between the engine and the main steam header developed a leak, steam blowing out around one of the bolts in the flange. Thinking that the gasket had given way, I had the joint opened and cleaned, a new gasket inserted, and the joint bolted up again. When the steam was turned on the joint still leaked.

When the joint was opened up again, the gasket was found to be in good condition, but by moving the pipe out of the way, so as to see in at the end of the valve, it was found that there was a sand hole in the body of the valve about one inch back from the face of the flange, extending through the body of the valve and coming out at one of the flange bolt-holes.

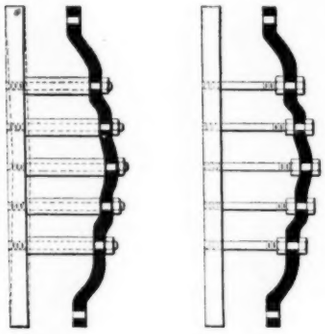
The problem was to stop this leak without replacing the valve, to do which it would be necessary to take two boilers off the line, which we could not do. Having on hand some tin foil taken from tape rolls and saved, I twisted some of it into a small rope, and with a small packing hook pushed it into the hole as far as it would go, and then packed it as tightly as possible by using a small hammer and punch, until the hole was packed solid.

When the flange was bolted up and steam at 150 lb. pressure turned on, the leak was found to have been stopped and it has not returned. The job required about three hours. O. V. BAKER.

Philadelphia, Penn.

A Second-Hand Condenser Overhauled

About a year ago I took charge of a plant when the first unit, a second-hand turbo-generator of 3750 kv.-a. capacity was being installed, bought because the manufacturers could not deliver a new machine in time. When the erector left, we could boast of 10 in. vacuum, but gradually we got it up to 27 in. and then found that we had too much water coming through, indicating a leak in the condenser. The tubes had been newly repacked, so all ferrules were tightened up and the condenser seemed tight, but still we had a lot of excess water. Another examination showed that one of the tube sheets was badly sprung.



CONDENSER TUBE SHEET STAYS

This condition had probably been caused by the distance pieces—the pipes put over the stay-bolts between the tube sheet and the outer head—being too short, so that when the nuts were pulled up tight the stay-bolts pulled the tube sheet outward and nearly off the end of the tubes, of course causing serious leakage. To correct this condition fifteen ¾-in. rods were put through as many tubes, all packing ferrules slackened and the sheet was drawn back fairly straight. The distance pieces were abandoned and the stay-bolts were threaded farther down, to take another nut on the inside of the head to take the place of the pipes, both shown in the illustration. It is obvious that with the head irregular in shape, it would be difficult to get all the distance pieces just the right length, but with the inside nuts on the stay-bolts, as described, the head is first put in place and the inside nuts adjusted to press lightly against the head, by reaching in through the handholes or inspection doors; then the outer nuts can be put on and tightened up without fear of buckling or pulling the tube sheet out of true. After once locating the inner nuts, the head can be taken off and replaced without disturbing them.

When the tube sheet had been stayed in the manner described, the through rods were taken out, and the condenser has given no trouble since. T. J. BURNS.

New York City.

Packing Water Pistons of Pumps

I do not consider the method of packing water pistons of pumps, described on page 664 in the issue of May 7, the best. I use square duck hydraulic packing for this work and split the last ring so as to give room for the packing to expand as it wears. When the liners or cylinders become so "worn in the center" as to shorten the life of the packing, I think it is time to make repairs. I have packed a 5 x 10-in. duplex feed pump that handled approximately 20,000 lb. of hot water per hour in this manner, and the packing lasted six months or more, and "ran without slip." This pump had brass expanding rings under the soft packing, however.

"Clamping packing as in a vise" may make it last, but there will be no benefit from it. Why pack it at all?

Philadelphia, Penn. T. A. MARSHALL.

[But repairs are not always made as promptly as they should be. For some conditions and service either the "plunger-and-ring" or the "solid-piston" type of pump having no packing is recommended and preferred by manufacturers and engineers.—Editor.]

Supporting Effect of Boiler Heads

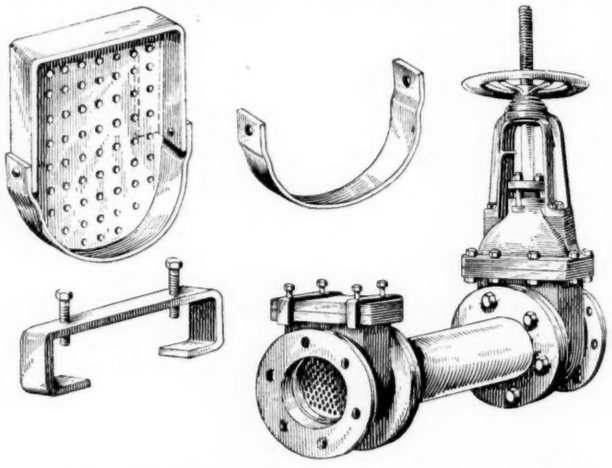
In the first part of the article by Mr. Macdonald, in the May 21 issue, he assumes that the head will collapse on the application of any overpressure, or any pressure greater than the holding power of the head, if there were no brace, or rope.

Suppose, for the sake of argument, that that is true, although I do not think it is. Then take up the last part of the article. If the strength of the whole is only the strength of the stronger part, or the furnace sheet, why add the weaker part, or the stay-bolts, to say nothing of weakening the stronger part by putting in useless stay-bolt holes? FRANK MCLEAN.

Chester, Penn.

Screen for Suction Line

The 6-in. suction line of the pump that supplies cooling water for the gas engines extends into a creek, in which a lot of refuse and leaves float, and it sometimes got choked up. To remedy this trouble the chief put a strainer in the body of an old 6-in. gate valve, as shown in the illustration, and connected it into the suction. The strainer was made of ⅛-in. sheet iron, shaped to fit into the groove originally occupied by the gate, drilled full of $\frac{5}{16}$-in. holes. An angle frame formed



STRAINER TO GO INTO BODY OF OLD GATE VALVE

to the shape of the space was riveted on to stiffen the strainer and catch the leaves when the strainer was withdrawn for cleaning. The cover and clamps for holding it down are shown and easily understood from the illustration.

To clean the strainer, the pump is shut down and the valve closed, clamps and cover plate are removed and the strainer lifted out, all of which is easily and quickly accomplished. We have found all manner of things in the strainer, including fish, water-dogs, and snakes, that would otherwise have gone into the pump.

Kittanning, Penn. R. G. CURREN.

Parallel Operation of Direct-Current Generators

[The following questions raised by E. Merrill concerning the article, "Parallel Operation of Direct-Current Generators," by T. F. Barton, appearing in the Apr. 16 issue, no doubt will be of interest to many readers of *Power*. Therefore Mr. Merrill's inquiries and Mr. Barton's reply to them are presented in the following.—Editor.]

Referring to the article by T. F. Barton in the Apr. 16 issue, there are a number of questions I should like to hear further discussion on, since they are not quite clear to me and no doubt to many other power-plant men.

1. In regard to commutating-pole generators, is it perfectly proper to shift the brushes in order to obtain a characteristic similar to another machine, or is there a point of brush position where we obtain a greater capacity and would therefore look elsewhere to adjust for a proper characteristic?

In the plant in which I am employed there are three compound-wound commutating-pole exciters operating in parallel, and we have considerable trouble from one of the machines taking the load and reversing the polarity of the others. In making the first adjustment for parallel operation, the brushes were shifted until satisfactory operation was considered to be found. Another electrician comes along and says it's all wrong by such adjustment, and that the capacity of the machine has been reduced. He then adjusts the brushes to correct commutating neutral by means of a millivoltmeter and changing the shunt of the series winding, which is considered the proper method of adjustment.

2. These exciters are also under a Tirrill voltage regulator and should they be adjusted for a rising, drooping or flat characteristic, and why?

3. In Mr. Barton's article, page 547, next to the last paragraph in the first column, he says: "To obtain stability in parallel operation of compound-wound non-commutating-pole generators they must be connected together at points where a drooping-voltage characteristic results with increase of load." I would like an explanation of why we would obtain a drooping voltage characteristic at this point between the armature and series-field windings and not at some others.

4. On page 547 Mr. Barton says: "The real difficulty lies in the fact that while each machine has the same regulation at the line terminals, each does not have the same regulation at the point of equalization, and where one machine may compound entirely from the action of the compound field, another may compound but slightly from this source, but from the commutating field and brush position." How are we going to know that we are getting our compounding from the commutating field and not from the series-field winding?

5. There seems to be some one proper brush position with commutating poles. How are we to find that position and know that we have got it?

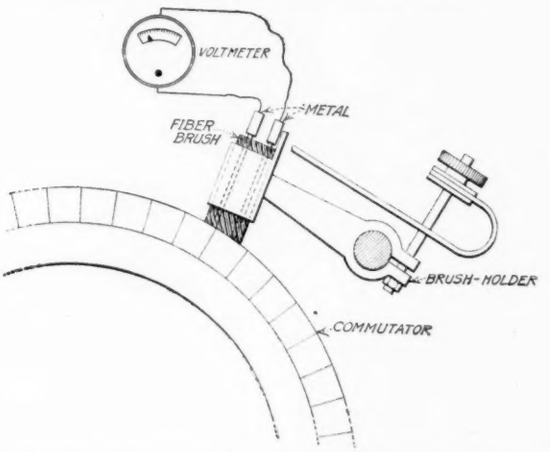
Buffalo, N. Y. E. MERRILL.

Mr. Barton's reply to these questions is as follows:

1. It is preferable to locate the brushes on the electrical neutral and make the adjustments on the commutating- and series-field windings to give the desired results. Brush shift has not been used to obtain results, but in general there is no objection to it, provided the final brush position is in a satisfactory commutating zone. The capacity of a machine is not reduced by shifting the brushes if rated voltage and current can be successfully obtained.

2. Exciters used in connection with Tirrill automatic regulators are flat or slightly under-compounded. The regulator controls the voltage of the exciter by rapidly varying the strength of its shunt field, and if too great a proportion of series-field winding is used, the action of the regulator is slowed up and the resulting regulation of the alternating-current generator is not so good.

3. Referring to the several diagrams, Figs. 7, 8 and 9, page 547, in the article in question, it will be seen that the equalizer in each case is connected on the machine side of the series-field winding. If the load was connected between the positive line and the equalizer instead of between the positive and negative lines, a drooping-voltage characteristic should result, since the volts drop in the armature due to the load is not compensated for. Without this drooping voltage characteristic successful parallel operation is impossible.



PILOT-BRUSH METHOD OF LOCATING BRUSHES ON THE NEUTRAL

4. In the case of two compound-wound commutating-pole machines, suppose each machine compounded flat at 125 volts. Also suppose No. 1 machine as a shunt-wound, commutating-pole unit, compounds 125 volts at no load and 120 volts at full load, while No. 2 unit under the same conditions compounds 125 volts at no load, 110 volts full load. It is to be expected that the series-field winding in the case of No. 2 machine is much more effective, and any change of current in this field, with regard to the armature current, changes the voltage much more than in the case of No. 1 machine. To determine the effectiveness of the series-field winding on any machine, it is necessary to take the voltage-regulation curves with and without the series-field winding connected in circuits.

5. There are many methods of locating the electrical neutral on direct-current machines. Two of these methods are as follows:

a. With the machine running at no load, normal speed and voltage, shift the brushes until a low-reading voltmeter shows no deflection when connected to points just inside the heel and toe of a pilot brush. The pilot brush must be the full size of the brushes used on the machine and can be made of fiber or wood with holes drilled

through it to allow contact on the commutator at the desired point, which should be at the center of two adjacent commutator bars as indicated in the figure.

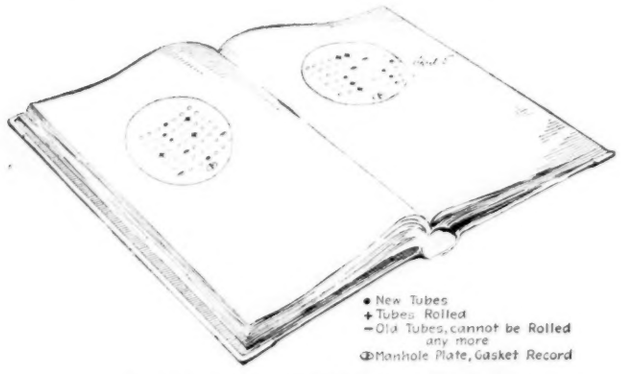
b. Operate the machine as a shunt-wound commutating-pole motor, checking the speed in both directions of rotation, holding the same value of armature voltage and shunt-field current in each case. The brushes are on neutral when the speed is the same in each direction of rotation.

T. F. BARTON.

Schenectady, N. Y.

Keeping Record of Boiler Tubes

I had charge of a number of horizontal-tubular boilers, and in the log I kept there was a sketch, as illustrated, which I found to be an easy means of keeping track



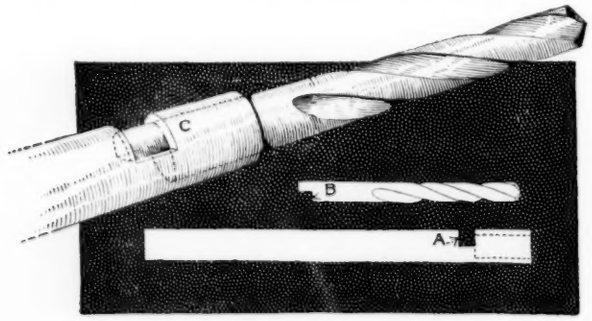
LOGBOOK OF RETURN-TUBULAR BOILER

of tubes in boilers and their condition without opening the doors to examine them. A notation in the logbook, giving the date of any work done or condition on inspection, was sufficient record for future reference. Symbols may also be used on the sketch.

Hudson Heights, N. J. B. DAN DE PASS.

Home-Made Drill Extension

Where an extension drill is required and one is not readily at hand, the deficiency can generally be supplied by boring a hole, about ¾ in. deep and of a diameter equal to that of the drill to be used, in one end of a piece of cold-rolled steel and then cutting a square notch in the side of the bar at the bottom of the hole, as shown



TWIST DRILL AND EXTENSION

at *A* in the figure. Then a short section is cut out of the end of the drill, as indicated at *B*, so that when the drill is placed in the extension, it will fit up into the notch of the latter, as indicated at *C*, and the two flat surfaces will act to prevent the drill from turning.

Cincinnati, Ohio. C. LEES, JR.

Engineer (?) Wanted

The advertisement herewith was clipped from the Cleveland *Press* of a recent date. I have heard of engineers being called on to perform various "outside" jobs, but this one seems to me the "best ever." Even if the

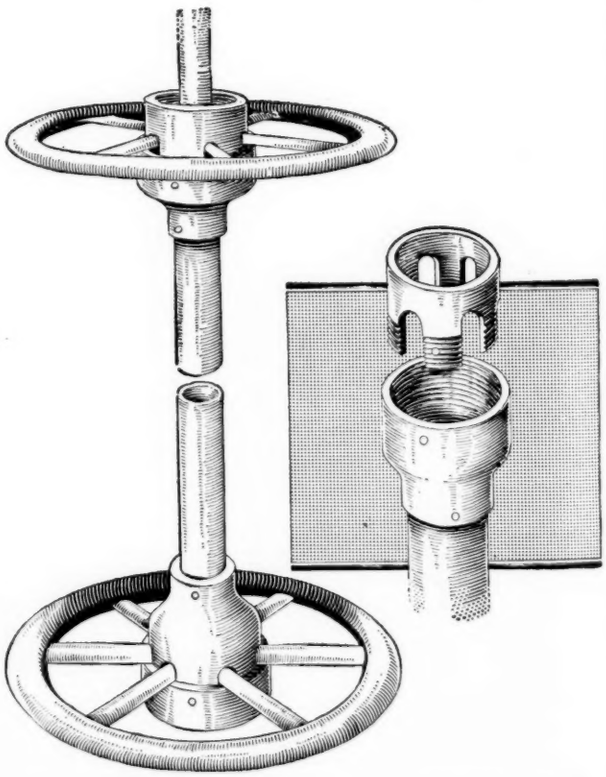
> **LICENSED ENGINEER**
> **Must be experienced in skinning cattle for rendering works, good pay.**
> **See H. E. Sobul**
> **722 Citizens Bldg. Main 5314.**

"successful" candidate has been a close student of *Power*, I fear he has never found instruction therein pertaining to the special requirement of this job.

Cleveland, Ohio. MALCOLM PAPWORTH.

Valve-Stem Extension

The engineer is frequently confronted with the necessity of extending the stem of a valve that has been located in some awkward place, hard to get at. Although there are many suitable devices on the market, it is often up to the engineer to devise and make some sort of a rig from any material at hand. The illustration shows an extension that is easily made of material that is to be found in most power plants. No minute description seems necessary. The construction shown at the lower end is better mechanically and probably preferable in most cases.



EXTENSION STEM ATTACHED TO OVERHEAD VALVE

L. V. LAUTHER.

Guttenberg, N. J.

INQUIRIES OF GENERAL INTEREST

Leakage Shown by Indicator Diagram—How can leaky valves and piston be discovered by inspection of a steam-engine indicator diagram from a Corliss engine? W. L.

Steam valve leakage usually is indicated by the expansion line being too high, especially toward the end of the stroke, while a leaky piston or exhaust valve will be shown by too low an expansion line. Leakage of a steam valve may combine with leakage of the piston or of the exhaust valve in such a manner as to produce a good expansion line.

Pop and Blowdown of Safety Valve—Why does a pop safety valve open suddenly and continue to blow down after the boiler pressure has been reduced below the pressure at which the valve is set to open? J. H. L.

The form of the valve is such that after it has opened there is a larger valve area acted upon by the steam, and this together with the reaction of the escaping steam assists the boiler pressure in opening the valve wider and in holding it open. Hence, while the valve is open, the static force of the boiler pressure is only part of the force that keeps it open, and it remains open until the total force has become reduced to the original force from reduction of the boiler pressure to a point below the original boiler pressure.

Use of Lap Joints for Girth Seams—Why are single-riveted lap joints used for girth seams of externally fired boilers, and why are double-riveted lap seams sometimes used for girth seams of locomotive boilers and for steam drums? F. M.

Single-riveted girth seams are adapted for shells where the tension is low and where the proximity to the fire makes it necessary to employ joints with as little metal as may be consistent with strength. The rigidity of the joint is increased by the circular form of the shell, and there is little tendency of distortion and bending action that exists when a lap seam is used as a longitudinal joint. Double-riveted lap joints are used for girth seams of locomotive and internally fired boilers and for long steam drums, to resist severe transverse stresses.

Equivalent Evaporation from and at 212 Deg. F.—A boiler generates 1000 lb. per hour of steam having a quality of 98 per cent. If the gage pressure is 100 lb. and the temperature of the feed water is 100 deg. F., what is the equivalent evaporation from and at 212 deg. F.? J. J. H.

According to the steam tables, a pound of dry saturated steam at 100 lb. gage, or 115 absolute, contains 309 B.t.u. in the water and 879.8 B.t.u. latent heat, and when the steam is 98 per cent. dry each pound contains $309 + (879.8 \times 0.98) = 1171.2$ B.t.u. above 32 deg. F. With feed water at 100 deg. F., each pound of feed water must have received $1171.2 + 32 - 100 = 1103.2$ B.t.u. For evaporation from and at 212 deg. F. each pound of water would require 970.4 B.t.u., and therefore the factor of evaporation is $1103.2 \div 970.4 = 1.136$, and evaporation under the actual conditions is equivalent to $1000 \times 1.136 = 1136$ lb. of water evaporated per hour from and at 212 deg. F.

Slamming of Corliss Valves—What causes Corliss valves to slam and what is the remedy? J. C. B.

A Corliss valve slams when the pressure on the back of the valve is not sufficient to continuously hold the valve to its seat in opposition to pressure that tends to force it away from its seat. The steam valves may slam from being raised from their seats by compression of the exhaust reaching a higher pressure than the steam-chest pressure, and obviously, the remedy is to increase the steam-chest pressure by less throttling or more boiler pressure, or else to decrease compression of the exhaust by closing the exhaust valve later. Slamming of the exhaust valves usually results from expansion falling below back pressure on the exhaust. This is common where an engine is very much underloaded, and the remedy is to obtain later cutoff by running with lower boiler pressure or by throttling, or holding up the final pressure by a small connection between the indicator cocks of opposite ends of the cylinder, or by slightly opening cylinder waste cocks to break the partial vacuum, or by reducing the back pressure on the exhaust.

Coal Required for Heating Water—How much coal would be required to heat 2000 gal. of water per hour from 60 to 190 deg. F., using steampipe coils in an iron tank with 250 sq.ft. of tank surface exposed to the atmosphere at a temperature of 50 deg. F.; the steam-heating coils to be supplied with steam at 5 lb. pressure and condensate from the coils to be returned to the boiler at 190 deg. F. with an actual evaporation of 8 lb. of water per pound of coal? J. J. N.

Allowing $8\frac{1}{3}$ lb. of water per gallon, the heat absorbed by the water would be $2000 \times 8\frac{1}{3} \times (190 - 60) = 2{,}166{,}666$ B.t.u. per hour. The average temperature of water in the tank, if heated with a uniform rise of temperature, would be $(60 + 190) \div 2 = 125$ deg. F., and allowing for the loss of heat by radiation from the tank surface at the rate of $2\frac{1}{4}$ B.t.u. per square foot per degree difference per hour, this loss would amount to $250 \times (125 - 50) \times 2.25 = 42{,}187$ B.t.u. per hour and the total heat required would be $2{,}166{,}666 + 42{,}187 = 2{,}208{,}853$ B.t.u. per hour. To keep the heating coils clear of condensate, only the latent heat of the steam would be realized, and as this for steam at 5 lb. gage is 960 B.t.u. per pound of steam, then with an actual evaporation of 8 lb. of steam per pound of coal and without any allowance for loss of heat in transmission of the steam from the boiler to the heating coils, the coal required would be $2{,}208{,}853 \div (960 \times 8) = 287.6$ lb. per hour.

Required Size of Aperture To Discharge Boiler Output—The temperature of the feed water of a 100-hp boiler is 115 deg. F. What diameter of aperture made in the steam space and open to the atmosphere would prevent accumulation of more than 5 lb. boiler pressure? F. T.

A pound of steam at 5 lb. boiler pressure, or 20 lb. absolute, contains 1156.2 B.t.u. above 32 deg. F., and with feed water at the temperature of 115 deg. F. each pound of feed water evaporated into steam at 5 lb. gage would receive $1156.2 + 32 - 115 = 1073.2$ B.t.u. Evaporation of a pound of water from and at 212 deg. F. requires the latent heat of evaporation, or 970.4 B.t.u., and the factor of evaporation would be $1073.2 \div 970.4 = 1.106$. A boiler horsepower is equivalent to the evaporation of $34\frac{1}{2}$ lb. of water per hour from and at 212 deg. F., and therefore the aperture would have to discharge steam at the rate of $(34.5 \times 100) \div 1.106 = 3{,}119.3$ lb. of water per hour. Napier's approximate formula for the discharge of steam from an aperture into the atmosphere is

$$W = P \times A \div 70,$$

in which

W = Weight of steam flowing, pounds per second;
P = Absolute pressure of the steam, pounds per sq. in.;
A = Area of aperture in square inches.

As the steam to be discharged per second would be $3119.3 \div (60 \times 60)$, by substituting this value for W and 20 lb. for P, the formula becomes

$$\frac{3119.3}{60 \times 60} = \frac{20 \times A}{70}$$

from which $A = 3.032$ sq.in., or an aperture of about 2 in. diameter.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—Editor.]

Economic Effects of Impurities in Coal*

Sets forth the many troubles and losses met in burning coal containing large quantities of impurities.

W. S. GOULD[1]. During the last two years, as prices have mounted higher, the quality of the fuel shipped to market has decreased until lately the lack of quality of the so-called coal available to the power plants of the country has become a decided menace not only to our economic development, but to the safety of the nation. It is incumbent upon everyone to become familiar with the dangers of the situation and to use whatever influence he may have to force an immediate change in this aspect of industrial activity.

Efficiency Loss from Ash

The Bureau of Mines estimated that the ash of coal mined in 1917 had increased 5 per cent. for the whole country, and that this increase in the ash content meant a further loss of 7.5 per cent. in the efficiency of the power plants. Some of the mining districts show a much higher increase in this element in coal. However, taking the Bureau of Mines estimate, this means, in figures of tonnage, that while we produced and shipped 544,000,000 tons of fuel in 1917, the tonnage was equal in effective power-producing qualities to only 476,000,000 tons of the 1916 quality. In other words, in 1917 we mined and shipped about 41,000,000 tons more of material than in 1916 to do 27,000,000 tons less work. Assuming that the work done by the 544,000,000 tons of poor coal was all we had to do, we mined and shipped some 70,000,000 tons simply to make up for the inferior quality. **This is the real cause of our coal troubles.**

Shipment of Weathered Coal

This, however, is not the whole story. While the increase in the ash content was fully equal to 5 per cent., the decrease in the heat was considerably greater than 5 per cent., this decrease being due to the fact that millions of tons of weathered coal were shipped—pillar and outcrop coal and refuse from mine dumps—all of which was considerably lower in heat in proportion to the ash content than would have been the case if the coal had been freshly mined from the seam. The Fuel Administration originally encouraged these "wagon mines," the number of which increased enormously, directly cutting down the available fuel.

Influence of Sulphur on Clinker

In addition to the well-established loss in efficiency and capacity of power plants due to the higher percentage of the ash impurity, we should not lose sight of the further loss due to the increase in the sulphur content. Sulphur in coal affects the economy of the boilers by forming clinkers, which hinder the proper distribution of air. This improper distribution may be excess or deficiency of air.

It has been found that while the drop in the combined efficiency of the boiler and furnace averaged about 0.5 per cent. for each 1 per cent. of sulphur between 0.5 and 6 per cent., the general drop in the boiler capacity is about 1.5 per cent. for each 1 per cent. of sulphur.

Before 1916 Eastern coals that carried sulphur in excess of 3 per cent. were not common. Since that time the cases of 5 and 6 per cent. sulphur, and some almost incredibly high, have steadily increased, until during the last winter it has been quite the exception to find coals with less than 2 per cent.

Then there is the damage that sulphur causes to the tubes, plates and grates of the equipment—a damage that is usually difficult to measure, especially since such damage is generally unexpected by the plant engineer or comes when he has no time to make exact calculations or cannot get information as to his coal.

WALTER N. POLAKOV:[2] The value of coal as used for power production is chiefly determined by its steaming capacity. Generally, there are two reasons for the condemnation of steam coals: (a) When the composition and peculiarities are unfit for *existing* equipment; (b) When impurities make it unfit for *any* equipment. Coals that are unfit for existing equipment or requirements should not be purchased at all, as they may be used to advantage elsewhere. The opinions on the subject advanced by miners, dealers, purchasing agents and accountants should be submitted for final disposition to engineers who are guided by facts.

Coals with a high percentage of noncombustibles were used by the author last winter in both hand and mechanically stoked furnaces. For instance, a mixture of 1 part run of mine and 5 parts of anthracite screenings was observed to show never less than 60 per cent. of boiler and furnace efficiency. This mixture contained: Ice and water, 15 per cent.; earthy matters, 28 per cent.; oxygen, 2 per cent.; total 45 per cent.

Results from Impurities in Coal

From a large number of observations with coals contaminated with noncombustible impurities that are thrown on the market by some dealers at the risk of the country's liberty and honor, several conclusions may be drawn:

a. While the efficiency of steam generation with so-called war coals drops from 10 to 25 per cent., the improved boiler-room management based on task work with bonus does invariably more than offset this loss.

b. The steaming capacity of coal drops along a parabolic curve; that is, with the increase of ash content the evaporation drops more rapidly in the beginning and more slowly when ash percentage is getting high.

c. It appears that the increase of ash content from 14 to 18 per cent. reduces the evaporation per pound of coal from 9 lb. to 8 lb. of steam (11.1 per cent.), whereas further drop of evaporation from 8 to 7 lb. per pound of coal (12.5 per cent.) corresponds with the increase of ash content from 18 per cent. to 28 per cent.

It should be noted that these data are obtained from a number of hand-fired plants using mixtures of hard and soft coal for a period of over 18 months. The means of recording the performances were in all cases most rigorous, specialists taking continuous checks on accuracy, firemen trained and methods of firing constantly adjusted to secure the best possible results. While the deviations of results with each kind of coal are sometimes large, due to difference in plant equipment and degree of training of firemen, the tendency of retarded drop of efficiency with higher percentage of ash remains noticeable throughout.

d. While extra cost of haulage and extra expense for the labor of handling coal and furnace refuse are easily estimated, the more important, though less noticeable, loss is due to difficulties connected with the admission of the proper amount of air into the furnace. If this is judged by the rate of firing pounds per hour, excess of air is inevitable with coals high in ash. Similarly, if direction is given by draft indications, extra resistance of fuel bed is liable to misguide the fireman. Again, if adjustments are based on gas analysis, the improper velocity of gases through the boiler may lower the efficiency of heating surface for the sake of high furnace efficiency, ultimately at the expense of combined efficiency. Also, losses are incurred by more frequent cleaning of fires.

e. By far the greatest economic effect of impure coals is the misuse of rail and water facilities for transporting the harmful, or, at best, useless, ingredients. The National Coal Association in a statement issued Apr. 28, 1918, announces that "Interference with the war program is

*From papers contributed to the Fuel Session, Spring Meeting, American Society of Mechanical Engineers, Worcester, Mass., June, 1918.

[1]President, Fuel Engineering Company of New York, New York. Associate Member A.S.M.E.

[2]Consulting Engineer, 31 Nassau St., New York. Member A.S.M.E.

almost inevitable throughout the East, unless there is a readjustment soon of the traffic over Eastern railroads." Production of coal lost because of car shortage is estimated by the same authority at about 20 per cent.

f. Instead of thus harrassing the Government in its task of operating railways and jeopardizing the country's production at this grave moment, the coal producers could disprove the charge of disloyalty by more careful preparation of coal at the mines. Cleaner coal will, as we have seen, not only release large parts of the rolling stock engaged in transporting dirt and slate, but also reduce the tonnage required for steam generation.

g. It is to be remembered, however, that half-measures toward preparation of cleaner coal at the mines will not go halfway in ameliorating the present car shortage and furnace wastes. By reducing ash percentage from 28 to 21 per cent., only seven cars out of every hundred will be released, yet by removing also the other half of impurities from coal (that is, placing the quality of coal on pre-war standard) the need will be satisfied with 78 cars out of every 100 now tied up.

To sum up, the vicious economic effect of impurities in the war coal can be overcome as follows: (a) A 20 per cent. car shortage may be taken care of by releasing 22 per cent. through reinstatement of previous quality of coal preparation; (b) further conservation of coal is possible by adopting more scientific methods of power generation and management of plants.

B. S. MURPHY:[3] The following notes are based on data from the Hudson & Manhattan Railroad Co., and especially from its Jersey City power station, which is an anthracite-burning steam-electric plant for an electric railway.

The boiler equipment consists of nine 900-hp. B. & W. boilers, eight hand-fired and one equipped with a mechanical stoker.

The fuel is anthracite of the small sizes. Our practice is to use Nos. 3 and 4 buckwheat mixed with bituminous and some No. 1 buckwheat, this latter with no soft coal added. All fuel, 115,000 tons of anthracite in 1917, came from the same contractor, and approximately all of it originated from the same collieries, so that the combustible portion of the coal should be relatively the same. In Table I are given the yearly averages and the maximum and minimum months during the year.

TABLE I. CALORIFIC VALUE AS FIRED, B.T.U.

Year	Minimum	Average	Maximum
1911	11,230	11,523	11,750
1912	11,050	11,428	11,650
1913	11,450	11,741	12,000
1914	11,550	11,912	12,050
1915	11,550	11,712	11,900
1916	11,150	11,563	11,850
1917	10,850	11,170	11,350
1918 (4 mos.)	10,750	10,900	11,150

An ash analysis gives relative values for the ash content of coal, but the true test is the proportionate amount of furnace refuse as compared with coal fired. Such a figure, taking into account the unconsumed carbon as well as the ash and other incombustibles for the amount and kind of ash, has a great bearing on the fuel in the ash, especially for hand firing.

EFFECT OF HIGH ASH

Some of the poorer coals have ash by analysis as high as 24.25 per cent., with 10,294 B.t.u. calorific value of wet coal, while the better ones have only 9 per cent. with 12,000 B.t.u., or a 15 per cent. difference. This would indicate that the limit for our coal was reached with about 30 per cent. ash, this having a greater effect on the mechanical manipulation of the fires than on the lack of heat value.

The foregoing is based on hand-fired operation where the impurities content and kind of ash have a much greater influence than with stokers. The railroad load having marked morning and evening peaks is subjected to this much more than a plant with an average all-day load. The presence of impurities builds up the fires so rapidly that at times it is difficult to get through the service period without cleaning and necessitates the carrying of high ashpit pressures, at times 7 in. water gage, to burn the fires. Another noticeable feature that we have found with the No. 1 buckwheat is the formation of a light, puffy ash that builds up the fires so rapidly that they last only about three-quarters of an hour between cleanings, while an analysis of this same fuel shows but 16 to 17 per cent. (gravimetrically) of ash, or a normal ash content, again showing that too much dependence cannot be placed on laboratory analysis for the effect on the fuel of the ash. As a rule, with anthracite the ash does not fuse into large, hard clinkers found with many kinds of bituminous coals; but even this has been noticed during the past winter, some of the clinkers being so large and so hard as to necessitate their removal through the fire-doors instead of through the ash hopper.

UNCONSUMED CARBON IN REFUSE

In our station it is necessary to force the boilers during the service hours to 140 to 150 per cent. rating. To do this with good firemen and good coal is not difficult, but when the impurities increase and the quality of men falls off, it is extremely hard, one affecting the other. It is necessary with the good grades of No. 3 buckwheat to level fires about every eight minutes, and with the high impurities and uneven spreading it should be done every three or four minutes. This is heavy, hot work; it is much easier to "bail" in coal, and the result is that the fire continues to build up because the ash and coked coal are covered with green coal until the fire becomes so heavy that it is impossible to get air through it. Cleaning then wastes a large amount of unconsumed carbon to the ashpit. The magnitude of this loss is shown in Table II. With good fuel and well trained, willing firemen this has been brought down to less than 20 per cent.

TABLE 2. LOSS OF COMBUSTIBLE TO THE ASHPIT

Month—1918	Unburned Carbon in the Refuse, Per Cent.
January	44.10
February	39.24
March	40.39

Summing up for the conditions as outlined for hand-fired boilers with the present grade of firemen available using Nos. 3 and 4 buckwheat coal with a relatively small percentage of bituminous, we find the following:

Calorific value, low limit, 10,200 B.t.u.; ash, high limit, 30 per cent., depending upon the behavior of the impurities.

Effect on Plant Economy: An increase in consumption per kw.-hr. of 53 per cent. from 12,000 B.t.u. to 10,500 B.t.u. coal. More coal is consumed, more coal is handled to the bunkers and to the fires and more refuse is removed, increasing the unit cost of power.

Effect on Personnel: Much hard work for firemen with the result that the better men leave for easier work, poorer men hired who use proportionately more coal and consequently make more work for themselves.

Capacity: The capacity of a plant is limited by the small evaporation per pound of coal and the much shorter periods between cleanings.

Remedy: If the amount of impurities and the correspondingly low calorific value cannot be remedied at the mines, where some of this should be eliminated, then the remedy at the fireroom is the increasing of the bituminous-coal content in the mixture, the introduction of mechanical stokers and the training of firemen, if the men can be induced to stay long enough to be trained.

W. L. ABBOTT:[4] In experiments made with a chain-grate stoker, using Illinois coal mixed with various percentages of ash, the capacity and efficiency of the unit dropped gradually with an increase of ash up to 35 per cent., after which they declined rapidly to zero efficiency and capacity with a fuel containing 40 per cent. ash. The fuel would still burn, but the boiler would not generate steam. The fuel used in the test was made by mixing various amounts of ashes with a clean pea coal, the ash content of which was about 8 per cent. Thus, in the final test, the coal containing 8 per cent. of ash was mixed with an additional 32 per cent. of impurities. A different furnace or stoker might have given a somewhat different result, but it is questionable if any

[3] Superintendent of Power, Hudson and Manhattan Railroad Co., Jersey City, N. J. Member A.S.M.E.

[4] Chief Engineer, Commonwealth Edison Co., Chicago. Member A.S.M.E.

other form of stoker would have handled a fire containing that great amount of readily fusible ash.

Results obtained from this series of tests, which were made by mixing ash with the coal, correspond with results obtained by the Bureau of Mines in tests made in St. Louis using coals with an inherent ash content ranging up to 25 per cent., above which point the bureau's tests did not go.

In a gas producer a fuel mixture of the kind first described would, no doubt, have given some useful results. A blast furnace always operates with a fuel mixture containing more than 40 per cent. of noncombustible. If a coal contained as much as 40 per cent. ash, it would not be marketable and might rather be called a bituminous shale. Marketed coal contains between 2 per cent. and 15 per cent. ash, as extremes, but is usually below 10 per cent. If the fuel mixture carries more, it is due to impurities which are associated with the coal; for example, a coal seam analyzing 10 per cent. in a seam sample may produce mine run containing 15 per cent. ash.

With increasing ash content there is a decreasing boiler efficiency and an increasing cost of the steam produced, and while coal containing nearly 40 per cent. of ash may produce some steam, it is rare indeed that it is economical to use coal containing as high as 20 per cent. ash.

H. KREISINGER:[5] In the outline of this topic is a statement. This statement that when a fuel contains 40 per cent. refuse the fuel becomes valueless cannot be applied generally as there are places where such fuel has economic value. In power plants located near the mines, washery refuse containing less than 50 per cent. combustible can be used profitably, especially if the furnaces are designed for burning such fuel.

BUREAU OF MINES TESTS WASHERY REFUSE

Some time ago the Bureau of Mines made a boiler test with washery refuse containing 41.8 per cent. of ash, 10.8 per cent. of moisture, 47.4 per cent. of combustible. The test was made under a 200-b.hp. Heine boiler set up with ordinary hand-fired furnace with plain grate. About 75 per cent. of the rated capacity of the boiler was developed with average over-all efficiency of 47.5 per cent. Of the 47.4 per cent. of combustible in the fuel, 8.6 went with the ashes into the ashpit, an equivalent of 22.5 was absorbed by the boiler, an equivalent of 10.4 went up the stack with the gases, and the equivalent of 5.9 was lost by radiation, incomplete combustion and moisture in fuel. The largest loss was up the stack due to large excess of air. The draft was 0.92 in. at the base of the stack, 0.06 in. in furnace, and 0.75 in. pressure in ashpit. The average thickness of fuel bed was 16 in. The fire was cleaned every hour. On account of the necessity of this frequent cleaning the average capacity fell below the rating of the boiler, although between the cleanings of fire the capacity developed was above the rating. It was also due to this frequent cleaning that the stack losses were high.

The essential requirement for the economical burning of high-ash fuels is a continuous and automatic removal of ash from the furnace, so that the operation of the boiler need not be interfered with by frequent cleaning of fires.

A few weeks ago the Bureau of Mines received a letter from the president of a mining company, who was planning a furnace for burning washery refuse running about 40 per cent. of combustible. This is a step in the right direction; the only place where it may be profitable to burn washery refuse or any other low-grade fuel is right at the source of such fuel so that the freight on the high ash is eliminated from the cost of the fuel. It would be wrong under the present railroad-car shortage to ship high-ash coal from the mines. At present the production of the coal mines is about 30 per cent. below normal, and most of the deficiency (about 26 per cent.) is caused by shortage of railroad cars. Therefore, the available railroad cars should be used only for hauling clean coal.

A. S. VINCENT:[6] The building of which I have charge is the largest apartment house in the world, occupies a whole block, has 175 families and is thoroughly equipped with a high-class isolated plant. Our horsepower-hour outputs for 1916 and 1917 were almost identical, and yet for 1917 we consumed nearly 1000 tons more than in 1916, due only to the inferior grade of coal. In other words, the coal consumption in 1916 was about 7000 tons and in 1917 it was 8000 tons. This plant is equipped with everything an engineer could desire to enable him to keep plant records.

Our cost per boiler horsepower-hour in 1916, including all overhead charges, was $0.0114 and for 1917 was $0.017, due almost entirely to the excess coal used and at a cost of more than double the 1916 cost.

[5]Engineer, United States Bureau of Mines, Pittsburgh, Penn. Member A.S.M.E.

[6]Superintendent and Mechanical Engineer, The Belnord Apartments, New York City. Associate Member A.S.M.E.

Oil Transportation and Conservation

The transportation and conservation of petroleum products is a subject to which the United States Fuel Administration is devoting its closest attention. As a war product petroleum occupies a position of prime interest. Ships, both in transocean and coastwise trade, are many of them dependent upon petroleum for motive power. Airplanes and motors, the number of which, now counted by the thousands, is constantly growing, use petroleum products exclusively for propulsion.

The movement of petroleum from the wells to the refineries and markets is accomplished by rail, by water and by pipe lines. These mediums of transportation are all taxed to capacity to accommodate the enormous demands of the Government and of commercial trade.

A large part of the water transportation, represented by tankers, formerly in coastwise service, bringing oil from Mexican and Gulf ports to Atlantic-coast refineries, has been commandeered by the Navy for transatlantic service. This heavy withdrawal of usual means of transportation facilities imposes upon the pipe lines, water lines, and the rail lines an extra burden.

As in the treatment of coal difficulties, the United States Fuel Administration seeks the coöperation of the public in meeting the obstacles that are presented in this branch of its activities. Patriotic assistance can be rendered if all those in any way connected with the transportation and consumption of petroleum products will act upon the suggestions that follow:

Increase storage capacity to avoid shutdowns during periods of congested transportation.

Provide adequate unloading facilities.

Avoid delays to tank cars, oil barrels or other containers, whether loaded or empty.

Practice efficiency and economy in consumption.

Delay in the movement of tank cars or other oil containers involves a serious responsibility. Prompt action in unloading and storing tank and barrel contents and returning them to the source of supply will greatly assist the Government in its treatment of the fuel problems.

Promptness and economy will assist the Government in winning the war. Delays will help the Kaiser.

New Power Plant Completed

The big power plant of the St. Anthony-Ashton Power Co., near St. Anthony, Idaho, has been completed and placed in operation. The power house is of concrete and is 33 x 72 x 26 ft. and is large enough to contain three units, only one of which is installed at the present time although the second is in transit and the other will be installed the first of next year. The turbines are capable of developing 3150 horsepower. The alternating-current generator is of 225-kw. capacity, 1800 volts, full load 2300 volts. The cost of the plant to date is estimated at $450,000 and the two additional units will cost $60,000 each.

There are now 72 miles of transmission line to Mud Lake, where there are four step-down substations, furnishing 600 hp. for the big pumps at the lake. The dam is 320 ft. wide at the top, 20 ft. wide at the bottom and 62 ft. high and backs the water of the Snake river for a distance of five miles. There is sufficient water to develop 10,000 hp. The spillway is 72 ft. wide and the water is controlled by six 12 ft. horizontal gates.

Food Administration Urges Conservation of Ammonia

The following is a message from the Food Administration urging conservation of ammonia. The poster below may be obtained from the Administration by asking for it. It is in attractive colors, size 22½ in. by 16½ in.

During 1918, the Government should have for munitions alone 20,000,000 lb. of ammonia more than it is possible to make by working all the plants producing ammonia in this country to their maximum capacity.

This shortage will be greatly increased by the ammonia that will be furnished ice-making and refrigerating plants, but it is hoped that by appealing to the patriotism and business sense of all ammonia users and urging them to stop all waste and leakage, that the usual consumption may be

THE FOOD ADMINISTRATION'S POSTER.

curtailed to such an extent as will permit at least the most efficient plants to run; particularly where natural ice is not available.

The returns lately received show that much ammonia loss is avoidable. Many plants use less than one-twentieth of a pound per ton of ice made; while others use from one-half to one pound per ton. The same inexcusable waste is found in many refrigerating plants. The only reason that can be given for permitting the enormous waste and expense to continue at some plants is that the management has not informed itself as to what is a reasonable consumption and the operating force is indifferent about leaks that might easily be stopped but are allowed to continue.

A saving of 25 per cent. in the ammonia consumption of ice and refrigerating plants would mean several million pounds annually for munitions. Each pound will make twenty hand grenades. Late returns show this saving can be accomplished if all will stop the leaks. To start an effective campaign to bring about this saving, the following urgent requests are being sent to all plants:

1. Before starting your plant (or if it is now operating) see to it that the ammonia system is tight. The slightest smell of ammonia indicates a leak which should be located and stopped at once.

2. Small leaks may be detected by burning sulphur in their presence.

3. Leaks in condensers or tanks may be traced by the use of phenolphthalein testing paper, which can be obtained from your ammonia dealer.

4. Test for leaks daily and be on the lookout for them constantly.

5. See that the pump or compressor rods are true and properly aligned, and that the stuffing-boxes are properly packed with good packing.

6. Stuffing-boxes are the source of heavy losses. When subjected to extreme changes in temperature they must be carefully adjusted and lubricated to prevent leakage or heating. Packings of proper design and material correct stuffing-box troubles.

7. Another source of leak is the pitting or roughening of infrequently used valve stems (particularly those that are exposed to moisture) tearing the packing when they are opened or closed. This can be prevented by smoothing up the valve stems and keeping the exposed part of the stem covered with a heavy grease.

8. Care should be taken in the manipulation of expansion valves so as not to force liquid ammonia to the compressor; it will start leaks and may cause accidents.

9. Do not pump a vacuum on ammonia system unless absolutely necessary, as a vacuum tends to draw air into the system. No vacuum is necessary when charging ammonia into the system. When it is found necessary to purge the system of air, or other noncondensible gases, shut off and cool down the condenser or absorber to be purged. Do not blow direct to the atmosphere when purging, but carry the purge line close to the bottom of a receptacle containing slowly running water. Purge slowly. Noncondensible gases are indicated by bubbles rising to the surface, while a crackling sound indicates the loss of ammonia.

10. Your own business interest demands that you get every employee interested in this campaign. There is no better way to get them interested than to offer them a share of what they save.

The Food Administration urges you to give a bonus offer your favorable consideration and to put it promptly before your employees. The saving may be computed by finding the difference in fractions of a pound of ammonia used per ton ice made in 1917 and 1918. This difference times the tons of ice made in 1918 gives the total saving of ammonia in pounds, and pounds saved multiplied by cost price of ammonia gives the saving in dollars and cents.

The employees' share should be agreed upon when the campaign starts. It may be any part of the entire saving, but for this campaign 50 per cent. is recommended.

Initial charges for plants started in 1917 or losses due to accident should not be considered as ammonia consumed.

All employees (engineers, oilers, and repairmen) who assist in keeping the system tight and saving the ammonia should share in the bonus.

11. Each plant shall report on the first of each month on forms to be later furnished by the United States Food Administration, as follows: (a) Amount of ammonia in the system when it is fully charged; (b) Amount of ammonia put in during the past month; (c) Amount that will probably be required for the present month. (d) Ice made during the past month; (e) Average daily refrigerating duty (in tons refrigeration) during past month (aside from ice making); (f) Manufacturer furnishing the ammonia; (g) If you have had excessive ammonia loss state cause; (h) State the amount of uncharged ammonia on hand..... lb. Anhydrous.....lb. aqua; (i) Have you adopted a "bonus system" as recommended by the Government?

Ships Lack Boilers and Engines

Addressing the American Boiler Manufacturers' Association, at Philadelphia, a few days ago, Charles M. Schwab, director of Emergency Fleet Corporation, declared that the situation regarding marine engines and boilers was critical; he said 80 or 90 hulls were already in the water awaiting power equipment. To meet the emergency, all manufacturers of boilers, engines and other ship equipment and accessories are being urged to increase their capacity as much as possible and make extensions wherever needed, with Government funds, which will be available for this purpose.

In experimental work it is not wise to make two changes at the same time, as, if the result is satisfactory or unsatisfactory, the reason for either is still obscure.—*Marine Engineering.*

Evolution of the Aircraft Engine

The first man-carrying airplane flights were made in December, 1903, with the Wright Brothers' engine, developing 12 hp. power and weighing 152 lb., or 12.7 lb. per hp. In 1910, seven years later, the average horsepower of aëronautic engines had increased to 54 and the weight decreased to 5.7 lb. per hp. In another seven years, 1917, the average power output had advanced to 243 hp. and the weight decreased to 2.8 lb. per hp. In March, 1918, the Liberty 12 developed 432 hp. for a weight of 808 lb., or 1.86 lb. per hp. At the present time (May, 1918) the Liberty 12 is yielding a maximum of 450 hp. for a weight of 825 lb. or 1.83 lb. per horsepower.

The average consumption of fuel decreased from about 0.8 lb. per hp. in 1903 to about 0.65 lb. in 1914, since which it has slowly dropped to 0.55 lb. in 1918, and for the Liberty to 0.50 lb. The present Liberty consumption is approximately 0.46 lb. per horsepower-hour.

Illustrating the advance made, the Wolseley Co. in 1913 could obtain only 147 hp. at 1400 r. p. m. from eight cylinders, 5 in. bore by 7 in. stroke, or 18.375 hp. per cylinder. This is the same size cylinder as used in the Liberty, which now gives 450 hp., at 1800 r.p.m., from 12 cylinders, or 37.5 hp. per cylinder. Even if we reduce the Liberty results to the same speed as the Wolseley—that is, 1400 revolutions—the Liberty still represents a great advance, for at that speed 350 hp. is developed, or 29.2 hp. per cylinder. Moreover, the Wolseley weighed 4.9 lb. per horsepower as compared with 2.3 lb. for the Liberty at the same speed, or 1400 revolutions per minute.

Committee on Development American Society of Civil Engineers

The Board of Direction of the American Society of Civil Engineers has created a committee on development by the adoption, on June 18, of the following resolutions:

Resolved, that a committee be created to report on the purposes, field of work, scope of activity and usefulness, organization, and methods of work of the American Society of Civil Engineers, and to make recommendations concerning these matters; the committee to consist of one member chosen by each local association of members, and seven members at large appointed by the president.

Resolved, that the president be instructed to select from this committee an executive committee of not less than five nor more than nine members and to appoint the chairman of this executive committee, who shall also be the chairman of the general committee.

Resolved, that the president be instructed to prepare a precept for the general guidance of this committee.

Resolved, that this committee be requested to present to the Board of Direction a preliminary report, not later than Nov. 1, 1918, so that it may be printed and distributed to the membership in advance of the annual meeting in January, 1919, at which meeting it will be presented for discussion.

The resolutions were prefaced by a preamble setting forth the effect of world changes upon the work of the engineer, and indicating that such changes necessitate a broad survey of the functions and purposes of the society, to the end that it "may take its proper place in the larger sphere of influence and usefulness now opening to the profession." This action apparently marks the end of the ultra-conservative régime for which the society has been noted. It aligns the society with the forces that are to help bring order out of chaos when peace comes.

By this action the society has set an example for the other national engineering societies to follow, by the appointment of similar committees. The coöperation of four such committees would insure a program based on the broadest investigation and most thorough discussion of the engineer's relations to his work, to his professional brethren, and to society. The opportunity is such as has never before been put before the profession and it doubtless will not be neglected.

California Power Priority List

Direct control of the power industry of northern and central California in the districts aiding war work has been started by the California Railroad Commission by the appointment of H. G. Butler, assistant chief engineer of the commission, as power administrator for the state.

The shortage of hydro-electric energy in California has become so acute that hundreds of industries are faced with the possibility of having their power supply cut off. The first act of the new power administrator will be to build up a priority list and put it into effect at once. At a recent meeting of the Railroad Commission all the power companies operating in northern and central California had representatives present. Other in attendance were: Federal Fuel Administrator R. P. Merritt, Director of the Pacific Coast division of the Oil Division of the Fuel Administration, D. M. Folsom, Fuel Administrator for the Pacific Coast, A. E. Schwabacher, D. A. Dickie, representing the Emergency Fleet Commission. All spoke plainly of the drastic action that must be taken if California is to maintain its output of war supplies and ships. All power-company representatives expressed approval of the plan to put into effect a priority list. Following is a tentative list of the industries in the order in which it is proposed to cut off their supply of power: Breweries and beer bottling; wineries and distilleries; quarries, rock crushers, marble and granite works; electric signs and billboards; brick and clay-product manufacturers; cement manufacturers; gold dredging; mining; lumber and planing mills; paper, paper boxes, etc.; garages, auto-repair shops, auto and accessory factories; printing and lithographing; furniture, mattress, casket, trunks and cabinet factories; building and construction work; freight and passenger elevators (all industries); electric railways; cornice and sheet-metal works; hardware, plumbing and fixture manufacturing; ice cream and confectionery; laundry and cleaning establishments; typewriters, moving picture houses (light and power); paint, oil and varnish factories; tents, cordage and bags; wire works; match factories; oil refineries; salt manufacturers; can factories; tanneries; clothing manufacturers; newspaper offices; cold storage plants and ice making; chemical works, smelters; packing houses, canneries, meat markets; iron works, foundries, machine shops; reclamation; irrigation; sugar refineries; bakers and macaroni factories; flour and feed mills and grain warehouses; shipbuilding plants; wireless telegraphy; United States Government work; unclassified power and resale power for general distribution.

Would Link Up Power Companies

Plans for linking up the great electric power companies of New England were laid before the board of gas and electric light commissioners, Boston, by Henry I. Harriman, president of the New England Power Co., says the Boston *News Bureau*. The plans contemplate a line from Dedham to Sudbury which will enable the Edison Co. of Boston to interchange current with the New England Power Co., and another line from Millbury to the Connecticut line at Webster, enabling the New England Co. and the Narragansett Power Co. to do the same. The Dedham-Sudbury line will be 19 miles long.

Mr. Harriman expressed the belief that it will be a great public advantage to have the largest steam-electric plant in the state linked up with the largest hydraulic plant, thus enabling each to take current of the other in case of emergency. This particular line will also enable the Edison Co. to develop additional business in Framingham and vicinity.

Mr.Harriman said it was necessary for his company to obtain 40,000 additional kilowatt capacity in order to fill its orders, and it is planned to secure the additional capacity by means of the two lines mentioned, together with an extension of its existing plant at Uxbridge and the partial reconstruction of its plant at Hoosac Tunnel.

In order to finance the changes necessary, the company seeks permission to issue $600,000 of mortgage bonds and $350,000 preferred stock.

Internal-Combustion Engine Lubrication and Lubricants*

By P. H. CONRADSON

Viscosity test of value only when the user is familiar with the characteristics of the different crudes of which the oil is made. Flash point of oil of no consequence after it enters the cylinder. Evaporation loss is usually greatest in oils of low flash points. Carbon deposit renders spring piston rings imperative. Specific gravity in no way determines if oil will stand up under service conditions.

THE main consideration in the selection of oil for the various classes of service are not well understood. Too much weight is given to vague inferences as to the relative value of viscosity and flash point alone, without taking into consideration many other important factors; and while it is true that some few engine manufacturers have conducted exhaustive investigations to determine just what particular grade of oil should be used for their engines, the greater part of the work of developing suitable lubricants for the various combustion engines has been done by the refiners and dealers of oil.

While the determination of viscosity—that is, body or consistency at a given temperature—is one of the vital tests usually applied to lubricating oil for internal-combustion engines, it is of importance only when the user of the oil is thoroughly familiar with the characteristics of the different crude oils of which it is made and is sure that the mechanical condition calls for the use of an oil having the stated viscosity. Two oils of the same viscosity, made from different crudes, may behave quite differently under identical working conditions.

Viscosity Tests and Temperature

The determination of viscosity of an oil, to be of the greatest value, should be made not only at the lower temperatures, but also as near the temperature of its use as consistent. On the one hand, an oil of low viscosity might be preferable, since it absorbs less power than a thicker oil in the separation of metallic surfaces moving at a high velocity over each other; in other words, high viscosity means a high internal friction. On the other hand, if the oil is too thin it is more easily displaced from between the bearing surfaces, and a heavier oil might then be preferable, as the engine will be more flexible at low speed, owing to better seal and less leakage. Therefore, due consideration must be given to the influence of temperature on the viscosity, and to the necessity of selecting the proper grade for the service required.

Owing to the comparatively high temperature under service conditions, there generally is no trouble from the oil being too thick when once in use. However, an oil must possess a de ree of fluidity at ordinary temperatures—which are influenced by climatic conditions—suited to the method of supplying the oil to the working parts, so as to obtain proper lubrication at the start. A lubricating system with exposed pipes, especially a force-feed system, should have a lower "cold-test" oil to meet these conditions; while in a system where the oil is carried in a pump integral with the engine crank case and where the supply pipes are not exposed, all parts of the system quickly become sufficiently heated to promote a positive circulation and an oil with a higher "cold test" may be used with good results.

The flash point of an oil is of no particular value after the oil has once entered the explosion chamber, where the temperature is considerably higher than that of the flash point. Nevertheless, it is important to use an oil of sufficiently high flash point for reasons of economy if for no other, to resist the vaporization which takes place when the oil comes in contact with the highly heated surface of the piston head, and other parts below the piston. In considering this it is well to remember that with many oils there is little connection between the evaporation (heat) loss and the flash point. Investigation has shown that while two oils may have the same flash points, the percentages of evaporation loss at a given temperature may be quite different. Generally speaking, however, the evaporation loss is greater in oils having a low flash point.

Obviously, that oil which, when subjected to an evaporation test at a certain temperature, loses the least and leaves a residue that has been broken up or altered in character as little as possible by the heat treatment is the most desirable for lubrication of internal-combustion engines. Therefore, the evaporation and oxidation tests offer a promising means of examining the oil and noting the changes that develop in different oils under similar conditions of treatment.

Oil consists principally or entirely of compounds of carbon and hydrogen. At high temperatures these hydrocarbons decompose, forming volatile combustible gases and heavy hydrocarbons, or carbonaceous matter, and free carbon. This breaking up may be due to improper methods of refining or to the nature of the crude oil. Only the most highly refined and filtered oils should be recommended to meet these conditions.

Carbon Residue of Oils

Much has been written about the carbon residue of the oils for this class of service. The carbon in all oils can be fixed by driving off the oil vapors (without addition of air), leaving a layer of carbon deposit, called carbon residue. The condition of the carbon formation in the cylinder is somewhat different from that found in the carbon-residue test, due to the fact that in the cylinder the oil is spread out in a thin film on hot metal surfaces, and exposed to the burning gases of the explosion, which may carry widely varying amounts of oxygen to combine with the oil. Also, the amount of carbon deposited in the cylinders is governed by the amount of oil reaching the explosion chamber, and may depend to a great extent upon the mechanical fit of the pistons, piston rings and cylinders. It is expected that some oil will find its way into the combustion space, but it is assumed that it will be burned up without depositing an excessive amount of carbon on the cylinder walls and pistons.

One of the most injurious effects of improper lubrication is the formation of this carbon deposit around and under the piston rings. Such a deposit soon renders the spring rings inoperative; they become partly fastened in their grooves, and in this condition form one of the most prolific causes of cut and scored cylinders and broken piston rings. One of the causes of this trouble may be the use of too much oil. From the result of much investigation along this line it has been conclusively demonstrated that an oil with the lowest carbon residue, other things being equal, will leave behind the lowest carbon deposit in the explosion chamber.

In connection with the physical characteristics of the carbon deposit it is of importance to select a lubricant which leaves a loose and flaky or soft carbon deposit, easily removed, rather than one leaving a dense, hard deposit difficult to remove.

*From a paper before the American Society for Testing Materials, Atlantic City, June, 1918.

Development of Norway Waterfalls

Norway possesses an enormous amount of power in its waterfalls, which have so far been utilized only to a comparatively small extent for power and lighting purposes. Now during the war, when coal has been difficult to obtain in sufficient quantities and the price has risen to about ten times the cost before the war (which enormous rise for the greater part must be accounted for by the high transport expenses), the aim has been to become independent of coal by utilizing the water power to its utmost extent. It has been found that there will be available 15,000,000 horsepower when the different water powers are developed, and it is the intention to centralize this power so that it may be transmitted to all parts of the country.—*Commerce Reports.*

Coal Preparation and Coal Sizes*

By Osborn Monnett

There have been various estimates as to what the average increase in ash has been, due to poor preparation, careless mining, etc. Those who have come into personal contact with the actual production of coal, state that owing to the demand for increased capacity, impurities have increased in the coal from some mines. For instance, in a mine with poor roof conditions, poor floor conditions and a parting in the seam of coal, the miners have not taken the usual normal care in trying to see that these impurities are eliminated from the coal. On the other hand, in mines where the operating conditions are good, that is where the roof and floor conditions are of a hard nature, it will be found that it is almost impossible to increase the impurities, and the quality of this coal has fluctuated very little. The greatest difference in a mine of this kind has been in the preparation. It has been known that in instances where, for instance, a 1¼-in. lump coal was ordered, it would have the appearance of a mine-run coal when it reached its destination. The screens in some cases have been manipulated in such a way that the smaller sizes have been shot across at such speed that they do not have time to pass through the screen, but ride on over into the lump coal. This has had a tendency to affect the quality also, as well as the preparation, for generally speaking, the finer in size the coal the higher in impurities. For instance, coal passing through a 1-in. screen is usually higher in impurities than a lump coal. Thus, if some of this finer coal rides over into the lump coal the percentage of ash will be higher in the lump coal. The resultant screening will also be higher in ash because the screening has been robbed of some of its nut coal, thus leaving a greater percentage of a smaller-sized coal in the screening.

Few people appreciate the importance of the size of coal as affecting the economy of the plant. In Chicago the following sizes are available: Egg coal, pieces 3 x 6 in.; No. 1 nut, 2 x 3 in., sometimes called small egg; No. 2 nut, 1¼ x 2 in.; No. 3 nut, ¾ x 1¼ in.; No. 4 nut, ¼ x ¾ in.; No. 5 nut, less than ¼-in.; mine run and screenings, the latter being of sizes passing through a hole ¼ to 2 in. diameter. In outside districts less choice in size is offered, the sizes generally being slack or screenings, mine run and lump.

Hand-fired plants have the greatest latitude in choice of size, while some stoker plants are practically limited to one or two sizes. The size to specify will depend on the plant condition. Past experience should be a governing factor.

Coal is broken in the course of mining, again while being loaded into the mine cars, also when discharged into the railway cars, again when loaded into delivery wagons and finally when dumped on the boiler-room floor.

During all these operations it should be handled with the greatest possible care so as to minimize the breakage. A great percentage of coal is delivered by wagon or truck. This cost of delivery is one of the largest single items of expense next probably to freight charges.

It is known well that weather conditions make wagon delivery uncertain in the wintertime, and there should be an earnest attempt made by the consumer to provide against this emergency which comes each year. Deliveries are retarded and impossible at times, and to overcome these difficulties a reasonable amount of coal should be placed in storage. Those who will do this will relieve the situation for those who have not the room and otherwise cannot buy when coal is more plentiful.

Each plant should store or arrange to have stored for them, at least sixty days' supply of coal. Many plants are now burning prepared sizes of coal that could burn screenings, and thereby aid the coal situation materially.

The domestic trade demands prepared sizes, and with the large demand for steam coal in these sizes, there has resulted an oversupply of screenings. This size of coal cannot be stored generally and so should be used for current consumption during the summer months by all steam plants equipped to handle it. In this way the domestic demand may be supplied and the necessary stocks of storage coal for winter use may be accumulated. As the situation stands today, there are numerous mines in Illinois that are working short-handed, although having orders for all the sized coal they can supply, simply because they cannot dispose of the screenings that are produced as an incidental byproduct of sized coal.

*Excerpt from paper presented before the National Association of Building Owners and Managers, Chicago, June 21, 1918.

Conservation of Tin

The General War Service Committee of the Electrical Manufacturing Industry, with headquarters at 50 Church St., New York City, in a recent bulletin called the attention of electrical manufacturers to the necessity of economizing in the use of tin in the industry. It recommends the use of other metals whenever possible as follows:

The United States Government has assumed control of the importation and distribution of tin in the United States. Demand is made that the use of tin cease for all nonessential purposes and be reduced elsewhere to the minimum consistent with the production of material and apparatus which will function safely and satisfactorily.

If electrical manufacturers are to obtain their supply of tin, it will be necessary for every one to economize to the fullest extent possible.

The uses of tin are for three general purposes—babbitt metal, alloy castings, and tinning and soldering, in which tin consumption can be reduced by:

1. (a) The use of lead-base babbitt metal in substitution for tin-base babbitt metal. (b) The reduction of tin content in a tin-base babbitt where the use of the latter is necessary. (c) The use of the thinnest section of babbitt metal consistent with a satisfactory bearing. Babbitt is frequently wasted in thick linings. Layers of babbitt metal not exceeding $\frac{1}{16}$ in. thickness will make a very satisfactory lining if sweated to a proper backing metal.

2. The percentage of tin in most alloy castings is unnecessarily high. It is common practice in brass foundries to look on tin as the cure for most troubles in producing brass or bronze castings. Even a 1 per cent. reduction throughout the country would result in an enormous saving in the total consumption.

3. (a) Pure tin solder is frequently used where mixtures of lead and tin in varying proportions may safely be substituted. (b) Half tin to half lead solder is very commonly used, whereas a mixture of 55 to 60 per cent. lead is often equally satisfactory. In many cases lead may be safely increased to 70 per cent, with 30 per cent tin. (c) It is common practice to dip ends of leads and other parts to be soldered into molten tin in preference to common solder mixtures because mixtures when kept melted for a long time tend to separate into layers of different composition. The eutectic alloy, 63 per cent. tin to 37 per cent. lead, which melts at 180 deg. C., will not separate as long as this proportion is fairly well maintained. Use such a bath when soldering with lead-tin alloys and use tin only when parts must be soldered with pure tin.

The foregoing suggestions cover only a few means of reducing the consumption of tin to the necessary minimum. Other suggestions which you can furnish your General War Service Committee will be welcomed.

The war needs of our industry in this respect are fundamental; consequently, your immediate, active coöperation is of vital importance.—*Commerce Reports.*

Standard Sizes for Catalogs

At a recent session in Chicago of the National Catalog Conference, including representatives of purchasing agents, typothetæ, and various associations of paper and other industries, called by the standardization committee of the National Association of Purchasing Agents, the following resolutions were unanimously adopted:

Resolved, That catalogs be standardized to 6 x 9 or 7½ x 10⅝ or 8 x 11 in.; also resolved that we recommend for catalogs the manufacture of paper sheets ranging as follows, 25 x 38, 32 x 44 and 33 x 46 inches, with their double sizes; that we also indorse the weights of 40, 45, 50, 60, 70, and 80 lb. on the basis of 25 x 38, and that colors be limited to white and natural.

The standardization committee of the National Association of Purchasing Agents recommends that all catalogs meant for the use of purchasing agents be 7½ x 10⅝ in.—*Commerce Reports.*

Personals

Everett A. Greene and **Chester S. Allen** have been elected directors of Lockwood, Greene & Co., of Boston, Mass.

Harry V. Hunt, formerly general superintendent of the Consolidated Press Co., Hastings, Mich., is now general manager of the O'Neil Iron Works, Buffalo, N. Y.

W. H. Callan, general manager of plants, and **W. P. Pressinger,** general manager of sales, have been elected vice presidents of the Chicago Pneumatic Tool Co., Chicago.

A. V. Larson, formerly with the American Engineering Co. in Pittsburgh and Philadelphia territory, is now sales engineer of the L. E. Pollard Co., Inc., Minneapolis, Minn.

L. C. Sprague, formerly connected with the railroad department of the H. W. Johns-Manville Co., New York City, has been appointed special representative of the Chicago Pneumatic Tool Co., in connection with the sale of pneumatic tools to railroads.

Lewis S. Maxfield has resigned his position in the motive power department of the Interborough Rapid Transit and New York Railways companies, New York City, to accept the position of assistant engineer with the Nate-Earle Co., of the same city.

P. B. Findley, technical editor in the Department of Publicity, Westinghouse Electric and Manufacturing Co., has resigned to enter the training school at the University of Pittsburgh, where he will take a special course in radio work, with the Signal Corps. Before going to the Westinghouse company, Mr. Findley was editor of the "Electrical Age."

R. Sanford Riley, president of the Sanford Riley Stoker Co., Ltd., Worcester, Mass., and of the Murphy Iron Works, Detroit, Mich., has been requested by the Emergency Fleet Corporation to arrange for supervision of trial trips of all merchant ships now being turned out in this country. He will undertake the organization of this department for the Emergency Fleet Corporation, beginning July 1, but has an arrangement by which he will retain supervision of his other interests during his connection with the Emergency Fleet.

Charles A. Cahill, Administrative Engineer, recently appointed in Wisconsin for work of power-plant fuel conservation, was born in New Hampshire, Dec. 6, 1862, served a machinist's apprenticeship with prominent Corliss Engine builder in New England States, after which he worked as journeyman machinist for three years; worked for several engine-building firms in the Middle West as machinist, draftsman, erecting engineer and erecting superintendent; erected and operated the steam, refrigerating and electrical equipment for the largest cold-storage warehouse in the West from 1893-9, in 1900 was given direct charge of the steam and electrical operation of the four generating plants and eight substations of the Utility Company in Milwaukee. After ten years he was promoted to chief engineer and at the end of two years entered the consulting field independently. He has been in this line for the last six years, specializing on power-plant operation. He is an ex-president and member of the Milwaukee Society of Engineers; also a member of the National Association of Stationary Engineers.

Engineering Affairs

The Universal Craftsmen Council of Engineers will hold its 16th annual convention in Detroit, Aug. 5-10.

The International Union of Steam and Operating Engineers will hold its sixth biennial convention at Cleveland, Ohio, Sept. 9.

Miscellaneous News

Boiler Explosion Killed Two Men and injured five, two perhaps fatally, at the Alton Lumber Co.'s saw mill, at Selbyville, Upshur County, W. Va., July 2. The boilers had been condemned recently and were in use temporarily until new ones that had been purchased arrived. The entire portable sawmill outfit was destroyed by the explosion.

Engineers Protest Examining Board—Twenty-four steam-plant owners and operating engineers recently requested the city commissioners of Oklahoma City, Okla., to remove the City Examining Board of Engineers. The request is made on the ground that the members of the board are permitting too much personal feeling to enter into their work. It is understood that a meeting of the commissioners will be held soon, at which time it is probable that the matter will be taken up by them.

Reject Power Plant Project—Notice has been received at the land office at Yakima, Wash., that the application for Mount Adams power rights, a plan to harness glacial waters for power purposes, had been rejected by the General Land Office. The application was filed in August, 1916, by L. F. Harza. Maps accompanying the application showed a series of short canals intercepting several streams conveying water to a drop, where the power was to be generated.

New Marine Boiler Plant—All Government steamships constructed in shipyards along the Atlantic coast will be equipped with boilers to be manufactured in a $4,000,000 plant which the Government will establish at Richmond, Va. Two thousand skilled mechanics will be employed. The plant, which is expected to be producing boilers before the close of this year, will include foundry, machine shop and a boiler shop, with electric lighting and power. Its cost will be furnished by Emergency Fleet Corporation, and the Newport News Shipbuilding Co. will have general supervision of its construction and will operate it.

Will Enlarge Power Plant—From 10,000 to 14,000 hp. is to be added to the capacity of the generating plant of the Pacific Gas and Electric Co., Spaulding, Calif., according to plans which have been adopted. Two sets of plans have been prepared, one providing for the addition of 10 ft. to the top of the dam giving an increased storage capacity equal to 10,000 hp.; a second plan provides for the addition of 15 ft. to the top of the dam increasing the storage capacity and making 14,000 additional horsepower available. The estimated cost of the work is $130,000 for the first plan and $200,000 if the second plan is carried out. The water from Spaulding has a total fall of 3000 ft. and is used in four of the generating plants of the company.

Business Items

The Sullivan Machinery Co.'s Boston office has been moved from 185 Devonshire St. to Room 516, Boston Safe Deposit and Trust Co. Building, 201 Devonshire St. George E. Wolcott is the New England sales manager.

Trade Catalogs

Sterling Return Steam Traps. Templeton Manufacturing Co., Cambridge, Mass. Pp. 6 x 9¼ in. Describes and illustrates full line of steam traps and copper floats.

Melting Points of Chemical Elements and Heat Color Scale. The Brown Instrument Co., Philadelphia, Penn. An interesting chart printed in four colors showing the melting points of chemical elements, together with a heat-color scale giving a useful conversion table of Fahrenheit and Centigrade degrees. The color scale includes 50 elements from nitrogen to carbon and should be found valuable in all kinds of heat-treating work.

The Ingersoll-Rand Co., 11 Broadway, New York City, has recently issued the following new literature: Form 4039—8-page bulletin on Leyner shank and bit punch, for punching out holes in bits and shanks of hollow drill steel. Form 901—4-page flyer showing the complete line of "Little David" pneumatic tools. Tables of sizes and capacities are given and illustrations show all the tools and their applications. Form 9028—18-page catalog illustrating and describing equipment for sugar factory and refinery service. A separate Spanish edition of this catalog is also available for those who desire it. Form 9010—4-page catalog on the "Sergeant" ticket-cancelling box. Form 901-1—Single-page flyer on "Little David" calking machine. Form 888—4-page flyer on "Little David" evaporator-tube cleaning and other labor-saving pneumatic tools. Form 876—Single-page flyer on Ingersoll-Rand barometric condensing plants. Form 883A—Single-page flyer on Class "FP" steam engines, horizontal center-crank type with piston valves. Form 3015-1—4-page bulletin on "ER-1" portable mine-car air compressors. Copies free on request to nearest branch office or agent.

New Construction

Proposed Work

Mass., Boston—The Bureau of Yards & Docks, Navy Dept., Wash., D. C., plans to install air compressors here. Estimated cost $75,000.

N. Y., Brooklyn—The Bureau of Yards and Docks, Navy Dept., Wash., D. C., is in the market for a boiler and mechanical stoker. Estimated cost, $21,800.

N. Y., New York—The Bureau of Yards and Docks, Navy Dept., Wash., D. C., plans to install a heating system in the structural shop. Estimated cost, $60,000.

Penn., Philadelphia—The Bureau of Yards and Docks, Navy Dept., Wash., D. C., plans to install 4 boilers in the Naval Hospital. Estimated cost, $18,000.

Penn., Philadelphia—The Bureau of Yards and Docks, Navy Dept., Wash., D. C., plans to install air compressors here. Estimated cost $75,000.

Penn., Philadelphia—The Bureau of Yards and Docks, Navy Dept., Wash., D. C., will receive bids until July 22, for surface condensers and auxiliary pumps. Estimated cost, $40,000. A deposit of $10 is required for the plans and specifications.

Penn., Philadelphia—The Free Public Library, 13th and Locust St. will soon award the contract for the installation of a heating and electric lighting system in the proposed 1-story library on Chester Ave. and 51st St. P. H. Johnson, Land Title Bldg., Arch.

Md., Indian Head—The Bureau of Yards and Docks, Navy Dept., Wash., D. C., plans to install boilers and superheaters at the nitrate plant. Estimated cost $200,000.

Md., St. Helena—The United States Shipping Board, Wash., D. C., plans to install a steam heating system in the proposed 2 and 3-story school. Total cost, $300,000. Smith & May, 1133 Calvert Bldg., Baltimore, Arch.

Wash., D. C.—The Bureau of Supplies and Accounts, Navy Dept., will soon receive bids for furnishing at various Navy Yards, Schedule No. 1855, 70,000 sq. ft. high pressure insulating blocks, magnesia blocks, 175,000 lb. magnesia plastic cement, fiber asbestos felting, asbestos millboard, 38,725 lb. wick or rope asbestos packing, 47,750 lb. asbestos paper and 271,000 lb. plaster asbestos.

Wash., D. C.—A. L. Flint, General Purchasing Officer, Wash., is in the market for fuses, batteries, condulets, switches, etc.

Va., Richmond—The Federal Reserve Bank plans to install steam heating and electric lighting systems in the proposed 5-story bank. Sill, Buckler and Fenhagen, Arch., 11 East Pleasant St., Baltimore, Md., are preparing plans for same.

Tenn., Knoxville—The J. G. Duncan Co., 308 West Jackson Ave., is in the market for a second-hand, 100 kw., 3-phase, 60 cycle, 2300 volt, 125 lb., steam pressure steam turbo unit.

Ohio, Akron—Summit County Commissioners are having plans prepared by M. P. Laner, Engr., 707 Peoples Saving and Trust Bldg., for the construction of a 2½ mi. power and lighting line to furnish power and light to the new infirmary. Estimated cost, $11,000.

Ohio, Cleveland—The Board of Education plans to install a steam heating system in the proposed 1-story school on Royal and Ruple Rd. W. R. McCornack, Rockwell and East 6th St., Engr.

Wis., Eau Claire—J. H. Lowrence, Wabasha, Minn., plans to instal electrical power in connection with his proposed 4-story, 16 x 64 ft. storage plant. Total cost, $20,000. Nordyke & Mormon, Kentucky Ave. and Morris St., Indianapolis, Ind., Arch.

Kan., Baxter Springs—C. M. Mitchell is in the market for engine, boiler, air compressor, belts, etc., in connection with the proposed concentration plant to be erected near here. Total cost, $45,000. B. Shelton, Supt.

Kan., Baxter Springs—C. E. Phillips is in the market for engines, boilers, belts, etc., in connection with the proposed concentration plant. Estimated cost, $60,000 J. Phillips, Supt.

Kan., Galena—O. C. Hamilton, 803 Connors Hotel, Joplin, Mo., is in the market for air compressors, pipes, belts, etc., in connection with the proposed concentration plant to be erected near here. Estimated cost, $65,000.

Wyo., Lander—The Board of Education plans to install a steam heating system in its proposed 3-story, 80 x 120 ft. high school. W. Dubois, Cheyenne, Wyo., Arch.

Okla., Spavinaw—The Red Granite Copper and Water Power Co. is in the market for engines, boilers, belts, etc., in connection with the proposed concentration plant to be erected near here. Estimated cost, $25,000. W. E. Hudson, Tulsa, Supt.

Colo., Denver—The Windsor Farm Dairy Co., 1859 Blake St., is in the market for boilers and ice machines in connection with the proposed dairy products factory.

Wash., Puget Sound (Bremerton, P. O.)—The Bureau of Yards and Docks, Navy Dept., Wash., D. C., will receive bids until July 22 for surface condensers and auxiliary pumps. Estimated cost, $43,800. A deposit of $10 is required for plans and spec.

CONTRACTS AWARDED

R. I., Newport—The Bureau of Yards and Docks, Navy Dept., Wash., D. C., has awarded the contract for the installation of an ice machine and refrigerating plant to the Vilter Manufacturing Co., 910 Clinton St., Milwaukee, Wis. Estimated cost, $39,-378.

Conn., New London—The Bureau of Yards and Docks, Navy Dept., Wash., D. C., has awarded the contract for the installation of boilers in the Navy Hospital to E. Keeler Co., 238 West St., Williamsport, Penn. Estimated cost, $10,680—180 days.

N. Y., Whitesboro—The Board of Education has awarded the contract for the installation of a heating system in the proposed high school, to T. Breen Co., 414 La Fayette St., Utica. Estimated cost, $19,250.

N. J., Allenwood—The Board of Freeholders, Monmouth Co., Freehold, received low bids building a tuberculosis and power house, from Pierce & Shutts, Bradley Beach, $32,-683; for steam heat and power, from Miller & Brady, 210 East 38th St., New York City, **$14,087.**

Penn., Philadelphia—The Bureau of Yards and Docks, Navy Dept., Wash., D. C., received bids for mechanical equipment and piping for boiler plant at the aircraft factory, Navy Yard, here: (1) price and time for the piping in the boiler plant, pumps, tanks, heaters, appurtenances, air ducts, flue breeching and damper, moving and erecting boilers, installing forced draft fans and the electrical work as specified in paragraphs 31143; (2) price and time for steam distributing system and concrete trenches as specified in paragraphs 144-172; (2a) price and time added or deducted from (2) if the alternative for concrete trenches is installed as specified in paragraphs 173-178, from Raisler Heating Co., 129 Amsterdam Ave., New York City, (1) $73,080—150 days. W. G. Cornell & Co., 923 12th St., Wash., D. C., (1) $74,948—150 days; (2) $32,972; (2a) deduct $3,000. General Heating and Ventilating Co., 198 Milwaukee St., Milwaukee, Wis., (1) $75,989—145 days; (2) $49,-786—145 days; (2a) deduct $10,000.

Wash, D. C.—The Bureau of Supplies and Accounts, Navy Dept., received bids July 1 for equipment as follows:

Item 1—Six motor generators; Class 133, Schedule No. 4749½, from Electric Specialty Co., South St., Stamford, Conn., $405 (part bid); Hobart Bros. Co., Troy, Ohio, $1734; the Holtzer Cabot Co., 125 Amory St., Boston, Mass., $4595.

One motor driven, plain horizontal grinder; Class 135, Schedule No. 4752½, delivery Charleston, S. C., from Kemp Machine Co., 223 North Calvert St., Baltimore, Md., $12,-733; Landis Tool Co., Waynesboro, Penn., $8,500.

Item 1—Eleven various hp. motors; Class 140, Schedule No. 4757½, delivery Wash., D. C., from Allis Chalmers Manufacturing Co., West Allis St., Milwaukee, Wis., $44,-918; the Triumph Electric Co., South St., Oakley, Cincinnati, Ohio, $48,572; the Hobart Bros. Co., Troy, Ohio, part bid, $22,239; Reliance Electric and Eng. Co., 90 West St., New York City, $48,125; Carroll Electric Co., 714 12th St., Wash., D. C., part bid, informal, $2050; Century Electric Co., 19th and Pine Sts., St. Louis, Mo., part bid, $48,-080; Robbins & Meyers Co., Lagonda Ave. and Fairlow St., Springfield, Ohio, part bid, $22,708; Crocker Wheeler Co., Baltimore, Md., part bid, $30,419; Diehl Manufacturing Co., Trumbull St., Elizabeth, N. J., part bid, $19,877; Phoenix Electric Co., Mansfield, Ohio, part bid, $1295; Fidelity Electric Co., 331 North Arch St., Lancaster, Penn., $13,-019; Fairbanks-Morse Co., 101 Light St., Baltimore, Md., $42,635; General Electric Co., River Rd., Schenectady, N. Y., $43,568; Mechanical Appliance Co., 133 Stewart St., Milwaukee, Wis., part bid, $26,869; Ideal Electric and Manufacturing Co., 153 East 5th St., Mansfield Ohio, $45,256; Kimble Electric Co., 634 North Western Ave., Chicago, part bid, $2965; Lincoln Electric Co., East 38th and Kelley Ave., N. E., Cleveland, Ohio, $43,183; Wetmore Savage Co., 76 Pearl St., Boston, Mass., part bid, $23,005; Wagner Electric Manufacturing Co., 6400 Plymouth St., St. Louis, Mo., $47,676; Westinghouse Electric and Manufacturing Co., Hibbs Bldg., **$43,017.**

Wash., D. C.—The Bureau of Accounts and Supplies, Navy Dept., received bids July 5, furnishing equipment as follows:

Item 1—Three smokeless firebox, portable boilers; Class 187, Schedule 4802½, delivery Naval Training Station, Great Lakes, Ill., from Kewanee Boiler Co., Kewanee, Ill., $1963; L. R. Merritt & Co., New York City, $2279; J. Mohr & Sons, 349 West Illinois St., Chicago, $2293.

Item 2—One smokestack. Item 3—One breeching; Class 188, from Kewanee Boiler Co., Kewanee, Ill., $1369; L. R. Merritt & Co., New York City, $1581; J. Mohr & Sons, 349 Illinois St., Chicago, $1825; Young Bros. Co., 313 Franklin St., Detroit, Mich., $1354.

Item 4—One hot water steel tank; Class 189, from Kewanee Boiler Co., Kewanee, Ill., $276; Lord & Burnham Co., Irving-on-Hudson, N. Y., $253; J. Mohr & Son, 349 Illinois St., Chicago, $360; Young Bros. Co., 313 Franklin St., Detroit, Mich., $360.

Item 1—Two 35 hp. induction motors and control equipment; Class 191, Schedule 4804½.

Item 2—Three 15 hp. induction motors and control equipment, from Allis Chalmers Manufacturing Co., Milwaukee, Wis. (1 and 2), $3972; Fidelity Electric Co., 331 West Arch St., Lancaster, Penn., part bid, $1380; Ideal Electric and Manufacturing Co., 53 East 5th St., Mansfield, Ohio, $2970; Lincoln Electric Co., Woodward Bldg., $3329; Mechanical Alliance Co., 133 Stewart St., Milwaukee, Wis., part bid, $944; Reliance Electric & Eng. Co., 90 West St., New York City, part bid, $1490; Triumph Electric Co., South St., Cincinnati, Ohio, part bid, $1250; Transmission Ball Bearings Co., 191 Lafayette St., New York City, $4170.

Item 3—Two pieces $2\frac{7}{16}$ in. 20 ft. long, key seated, 1 end for double cone vise coupling, shafting.

Item 4—Two pieces $2\frac{7}{16}$ in. 16 ft. long, key seated on end for double cone vise coupling.

Item 5—Four pieces $1\frac{15}{16}$ in., 20 ft. long.

Item 6—Two couplings, $2\frac{7}{16}$ in. double cone vise, with key seats and keys; Class 192, from A. Brown Co., 79 Barclay St., New York City (3) (4) (5) and (6) informal bid; Carroll Electric Co., 714 12th St., $143; Dodge Sales & Eng. Co., 815 Arch St., Philadelphia, Penn., part bid, $13; Fidelity Electric Co., 331 West Arch St., Lancaster, Penn., $175; Fairbanks Co., Colorado Bldg., part bid, $16; Reliance Electric & Eng. Co., 90 West St., New York City, part bid, $12; W. Sellers & Co., Inc., 1600 Hamilton St., Philadelphia, Penn., $154.

Item 1—One 3½ ton friction drive gasoline locomotive, standard gauge, with enclosed cab; Class 207, Schedule 4782½.

Item 2—One 7½ ton heavy duty, gear driven locomotive, from Baldwin Locomotive Works, Broad and Spring Garden Sts., Philadelphia, Penn., $14 000; Cummings Machine Co., New York City, part bid, $4725; Fairmont Gas Eng. & Railroad Motor Co., Fairmont, Minn., part bid, $2656; C. Koch, bid, $1850; Vulcan Iron Works, Wilkes-Barre, Penn., part bid, $6600; G. D. Whitcomb Co., Rochelle, Ill., part bid, $7065.

Wash., D. C.—The Bureau of Yards and Docks, Navy Dept., Wash., D. C., received bids for boilers and superheaters for installation in the central power plants: (1) price and time for 4 boilers, superheaters and accessories, installed complete in Navy Yard, Brooklyn, N. Y.; (2) price and time for 4 boilers, etc., installed at the Naval Base, Hampton Roads Norfolk, Va.; (1a) and (2a) bids will also be received if based on the boilers and accessories as outlined under (1) and (2) and in accordance with the intent of this specification but with changes and modifications the bidder may desire, from Edgemoor Iron Co., Edgemoor, Del.: (1) $93,726—180 days; (2) $82,766—180 days. Babcock & Wilcox Co., 1010 North American Bldg., Philadelphia, Penn.: (1) $100,081 (2) $90,860 (1a) $81,761, with Sterling boilers (2a) $71,721, with Sterling boilers. Noted June 25 under "Hampton, Va."

Wash., D. C.—The Bureau of Yards and Docks, Navy Dept., Wash., D. C., has awarded the contract for improvements to the power plant here to Gillis & Geohegan, 537 West Bway., New York City, $44,806. Noted July 9.

Va., Norfolk—The Bureau of Yards and Docks, Navy Dept., Wash., D. C., received bids for the erection of a generating plant and the installation of power house piping, laundry equipment, etc., at the U. S. Naval Hospital Reservation. (1) price and time for the work complete; (2) price and time for the work complete omitting all laundry equipment and installation; (3) price and time for laundry equipment and installation, from W. G. Cornell Co., 923 12th St., N. W., Wash., D. C., (1) $57,835; (2) $38,884 (less engine and generator); (3) $17,950.

Hanley & Co., 5 North La Salle St., Chicago, (1) $97,000; (2) $81,000; (3) $20,000.

American Laundry Machinery Co., 134 West 37th St., New York City, (3) $14,535—40 days.

THE COAL MARKET

Boston—Current quotations per gross ton f.o.b. mines are as follows:

ANTHRACITE

	Circular Current
Buckwheat	$3.40
Rice	2.90
Boiler	2.65
Barley	2.40

All-rail rate to Boston is $2.86.

BITUMINOUS

Bituminous, $8 to $8.75.

Pocahontas and New River, f.o.b. Boston, $8.35 to $8.90.

New York—Current quotations per gross ton f.o.b. Tidewater at the lower ports* are as follows:

	Circular	Individual
Pea	$5.20	$5.95
Buckwheat	5.15	5.90
Rice	4.65	5.10
Barley	4.15	4.30
Boiler	4.60	....
Broken	6.75	7.50
Egg	6.35	7.10
Stove	6.60	7.35
Chestnut	6.70	7.45

Quotations for domestic coals at the upper ports are 5c. higher on account of the difference in freight rates. Prices for buckwheat, rice, barley and boiler are not fixed by the Government.

BITUMINOUS

Current quotations, gross tons, based on Government prices at the mines, net ton; f.o.b. Tidewater, at the lower ports, are as follows:

	Mine Gross	F.O.B. N.Y. Gross
Central Pennsylvania (Mine run, Prepared or Slack)	$3.30	$5.45
Upper Potomac, Cumberland & Piedmont Fields:		
Run of Mine	3.08	5.23
Prepared	3.36	5.51
Slack	2.80	4.95

Quotations at the upper ports are 5c. higher on account of the difference in freight rates.

The foregoing prices ar exclusive of the 3 per cent. war freight tax on both anthracite and bituminous.

*The lower ports are: Elizabethport, Port Johnson, Port Reading, Perth Amboy and South Amboy. The upper ports are: Port Liberty, Hoboken, Weehawken, Edgewater or Cliffside and Guttenberg. St. George is in between and sometimes a special boat rate is made. Some bituminous is shipped from Port Liberty. The ratte to the upper ports is 5c. higher than to the lower ports.

Philadelphia—Prices per gross ton f.o.b. cars at mines for line shipment and f.o.b. Port Richmond for tide shipment are as follows:

	Line		Tide	
	Current	One Yr. Ago	Current	One Yr. Ago
Pea	$3.45	$3.10	$4.60	$4.00
Barley	2.40	1.90	3.30	2.15
Buckwheat	3.40	2.90	4.45	3.80
Rice	2.90	2.40	3.80	3.40
Boiler	2.70	2.20	3.70	3.30

Chicago—Steam coal prices f.o.b. mines:

	Illinois Coals	Southern Illinois	Northern Illinois
Prepared sizes	$2.55—2.70		$3.25—3.40
Mine-run	2.35—2.50		3.00—3.15
Screenings	2.05—2.20		2.75—2.90

St. Louis—Prices per net ton f.o.b. mines are as follows:

	Williamson and Franklin Counties	Mt. Olive & Staunton	Standard
6-in. lump	$2.55-2.90	$2.55-2.70	$2.25-2.50
2-in. lump	2.55-2.90	2.55-2.70	2.25-2.50
Steam egg	....	....	2.25-2.50
Mine-run	2.35-2.50	2.35-2.50	1.90-2.10
No. 1 nut	2.55-2.90	2.55-2.70	.....
2-in. screen	2.05-2.20	2.05-2.20	.....
No. 5 washed	2.05-2.20	2.05-2.20	1.30-1.75

Williamson-Franklin rate to St. Louis is $1.10, other rates, $0.95.

Birmingham—Current prices per net ton f.o.b. mines are as follows:

	Mine-Run	Prepared Sizes	Slack or Screenings
Big Seam	$2.50	$2.80	$2.20
Cahaba, Black Creek, Brookwood, Blue Creek	3.20	3.45	2.80
Pratt, Jaeger, Jefferson Nickel Plate	2.70	3.00	2.40
Corona	2.75	3.10	2.40

The above are Government prices per net ton of 2000 lb. mines and include the 45c. per ton allowed by the wage agreement, less 10c. reduction which was effective May 25, as a result of the agreement with the railroad administration for furnishing fuel coal.